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DOE Contract No. DE-AC05-03OR22980
Job. No. 23900
LTR-PAD/EP-DH-04-0081
November 19, 2004

Mr. William E. Murphie, Manager
Portsmouth/Paducah Project Office
U.S. Department of Energy
1017 Majestic Drive, Suite 200
Lexington, Kentucky 40513

Dear Mr. Murphie:

DE-AC05-03OR22980: Transmittal—*Scoping Document for the Burial Grounds Operable Unit Remedial Investigation/Feasibility Study at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky* (DOE/OR/07-2178&D1)

Enclosed are five copies of the subject document for your review. This document incorporates the D0 comments received from the U.S. Department of Energy (DOE) on November 4, 2004, and DOE's November 10, 2004, comments on the D1 preliminary draft. Bechtel Jacobs Company LLC (BJC) will distribute the document as required by the *Standard Distribution List for Bechtel Jacobs Company LLC Primary and Secondary Documents (07/28/04)* after receiving DOE's approval to do so.

A signed DOE transmittal letter (suggested language enclosed) will serve as notification that DOE approves the enclosed document for distribution. Distribution of this scoping document by November 24, 2004, is critical to meeting the enforceable commitment for delivery of the D1 Burial Ground Operable Unit Work Plan by June 30, 2005. This enforceable commitment date will be seriously jeopardized if the scoping process, including the scoping meeting, is not completed before the end of this calendar year.

Below are the recommended steps and timetable for completion of the scoping process before the end of the year.

- DOE signs transmittal letter and approves the D1 scoping document for distribute no later than November 24, 2004.
- Fifteen-day regulator review begins no later November 29, 2004.
- Two-day scoping meeting held during the week of December 13, 2004 (the last full workweek in December).

If you require further information, please contact Fraser Johnstone of my staff at (270) 441-5206.

Sincerely,

Deborah K. Tolley for

Glenn E. VanSickle
Paducah Manager of Projects

GEV:EFJ:dfm

Enclosures (2): As stated

c/enc: Distribution

Distribution

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November 24, 2004

Mr. Bruce Scott, Director
Kentucky Division of Waste Management
Department for Environmental Protection
14 Reilly Road
Frankfort Office Park
Frankfort, Kentucky 40601

Mr. David G. Williams
U.S. Environmental Protection Agency
Region 4
DOE Remedial Section
Federal Facilities Branch
Waste Management Division
61 Forsyth Street
Atlanta, Georgia 30303

Dear Mr. Scott and Mr. Williams:

SCOPING DOCUMENT FOR THE BURIAL GROUNDS OPERABLE UNIT REMEDIAL INVESTIGATION/FEASIBILITY STUDY AT THE PADUCAH GASEOUS DIFFUSION PLANT, PADUCAH, KENTUCKY (DOE/OR/07-2178&D1)

Enclosed are your copies of the subject document. The Federal Facility Agreement calls for the scoping meeting to be held at least 15 days after the delivery of the scoping document. In order to maintain the schedule for achieving the enforceable commitment date of June 30, 2005, for delivery of the D1 Burial Ground Operable Unit Remedial Investigation/Feasibility Study Work Plan, it is critical to complete the scoping process in 2004. The U.S. Department of Energy suggests holding a two-day scoping meeting during the week of December 13, 2004.

If you have any questions or require additional information, please call Greg Bazzell of my staff at (270) 441-5080.

Sincerely,

William E. Murphie, Manager
Portsmouth/Paducah Project Office

cc:
G. A. Bazzell, PPPO/Paducah
R. H. Blumenfeld, PPPO/Lexington
J. R. Castañeda, PPPO/Paducah
DMC/Kevil
C. S. Jones/G. E. VanSickle, BJC/Kevil
P. W. Willison, BJC/Oak Ridge

11/30/04 cW

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DOE/OR/07-2178&D1
Secondary Document

Scoping Document for the Burial Grounds Operable Unit Remedial Investigation/Feasibility Study at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky

November 2004

I-05206-0002

CDM Federal Services Inc.

contributed to the preparation of this document and should not be considered an eligible contractor for its review.

DOE/OR/07-2178&D1
Secondary Document

Scoping Document for the Burial Grounds Operable Unit Remedial Investigation/Feasibility Study at Paducah Gaseous Diffusion Plant Paducah, Kentucky

Date Issued—November 2004

Prepared for the
U.S. DEPARTMENT OF ENERGY
Office of Environmental Management

by
Bechtel Jacobs Company LLC
managing the

Environmental Management Activities at the
Paducah Gaseous Diffusion Plant
Paducah, Kentucky 42001
for the
U.S. DEPARTMENT OF ENERGY
under contract DE-AC05-03OR22980

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CONTENTS

APPENDIX

FIGURES

TABLES

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ABBREVIATIONS AND ACRONYMS

^{99}Tc	technetium-99
amsl	above mean sea level
AOC	area of concern
ARARs	applicable or relevant and appropriate requirements
BGOU	burial ground operable unit
bgs	below ground surface
BTEX	benzene, toluene, ethyl benzene, and xylenes
cm	centimeter
cm/s	centimeter per second
D&D	decontamination and decommissioning
DNAPL	dense nonaqueous-phase liquid
DOE	U.S. Department of Energy
DPT	direct push technology
DQO	data quality objective
DRI	double-ring infiltrometer
DWRC	dual-wall reverse circulation
EM	Environmental Management
EPA	U.S. Environmental Protection Agency
FFA	Federal Facility Agreement
FOD	frequency of detect
FS	feasibility study
ft	feet
ft/day	feet per day
gal	gallon
GDP	gaseous diffusion plant
GDT	Geophysical Diffraction Tomography
GPR	Ground Penetrating Radar
GWOU	groundwater operable unit
HAS	hollow-stem auger
in	inch
KDEP	Kentucky Department for Environmental Protection
KPDES	Kentucky Pollutant Discharge Elimination System
L	liter
lb	pound
m	meter
MW	monitoring well
NCP	National Contingency Plan
NEPA	National Environmental Protection Act
NSDD	North South Diversion Ditch
OREIS	Oak Ridge Environmental Information System
OU	operable unit
PAHs	polychlorinated biphenyls and polycyclic aromatic hydrocarbons
PCB	polychlorinated biphenyls
PGDP	Paducah Gaseous Diffusion Plant
ppm	parts per million
RCRA	Resource Conservation and Recovery Act
RI	remedial investigation
RI/FS	remedial investigation/feasibility study

ABBREVIATIONS AND ACRONYMS (CONT.)

ROD	Record of Decision
SMP	Site Management Plan
SOU	soil operable unit
SVOCs	semivolatile organic compounds
SWMU	solid waste management unit
SWOU	surface water operable unit
TCE	trichloroethene
UCRS	Upper Continental Recharge System
U	uranium
VOCs	volatile organic compounds
WAG	Waste Area Grouping
WMU	Waste Management Unit

EXECUTIVE SUMMARY

The Paducah Gaseous Diffusion Plant (PGDP) is an active uranium enrichment facility that is owned by the U.S. Department of Energy (DOE). DOE is conducting environmental restoration activities at PGDP in accordance with the requirements of the Commonwealth of Kentucky and the U.S. Environmental Protection Agency (EPA) under the Comprehensive Environmental Response, Compensation, and Liability Act. PGDP was placed on the National Priorities List in 1994. DOE, EPA and the Commonwealth of Kentucky entered into a Federal Facility Agreement (FFA) in 1998 (EPA 1998).

This Remedial Investigation/Feasibility Study (RI/FS) Scoping Document has been developed to assist in preparation of the RI/FS Work Plan for the investigation and possible subsequent remediation of the Burial Ground Operable Unit (BGOU) at PGDP. The subject of this scoping document is the BGOU (Solid Waste Management Units [SWMUs] 2, 3, 4, 5, 6, 7, 30, and 145). The document utilizes a compilation of sampling information collected on and around PGDP over the course of the last ten years. The table below identifies the previously completed reports and/or investigations primarily used to prepare this scoping document.

Summary of previous assessments of on-site portions of BGOU

Dates	Title	SWMU 2	SWMU 3	SWMU 4	SWMU 5	SWMU 6	SWMU 7	SWMU 30	SWMU 145
1989	Post Closure Permit Application C-404 Low-Level Radioactive Waste Burial Ground		√						
1996	Closure Plan C-404 Low-Level Radioactive Waste Burial Ground		√						
1996-1997	WAG 22 SWMUs 2 and 3 Remedial Investigation and Addendum	√	√						
1996-1998	WAG 22 SWMUs 7 and 30 RI/FS Investigation						√	√	
1998-2001	WAG 3 RI/FS Investigation			√	√	√			
1999-2001	Data Gaps Investigation			√	√		√	√	√
2000-2001	Old North-South Diversion Ditch Sampling								√
2002-2003	Scrap Yards Site Characterization				√	√	√	√	
2003-2004	C-746-S&T Landfill Site Investigation								√

WAG-Waste Area Grouping

PROJECT OBJECTIVES AND GOALS

The goals for the BGOU RI/FS are consistent with those established in the Paducah Site FFA and the Paducah Site Management Plan (SMP) (DOE 2004) negotiated among DOE, EPA, and the Kentucky Department for Environmental Protection. The FFA requires that PGDP identify, investigate, and remediate all areas of concern and SWMUs that could potentially pose a threat to human health and the environment. The goals of this RI/FS are as follows:

- Goal 1: Characterize Nature of Source Zone—characterize the nature of contaminant source materials using existing data, and if required, by collecting additional data;

- Goal 2: Define Extent of Source Zone and Contamination in Soil and Other Secondary Sources at All Units—define the nature, extent (vertical and lateral), and magnitude of contamination in soils, sediments, surface water, and groundwater; determine the presence, general location (if practicable), and magnitude of any dense, nonaqueous-phase liquid zones as defined in the Paducah SMP (DOE 2004);

- Goal 3: Determine Surface and Subsurface Transport Mechanisms and Pathways—gather existing, and if necessary, collect additional adequate data to analyze contaminant transport mechanisms and support a feasibility study; and

- Goal 4: Support Evaluation of Remedial Technologies—determine if the existing data are sufficient to evaluate alternatives that will reduce risk to human health and the environment and/or control the migration of contaminants off-site.

During development of this scoping document, existing data were evaluated in relation to the Data Quality Objectives (DQO) defined in this scoping document. The outcome shows that either data gaps exist for a SWMU or that sufficient data are available to move forward with an FS. The table below describes those data gaps identified thus far in the scoping process.

Summary of additional data needs for the BGOU

SWMU	Summary of Additional Data Needs
SWMU 2	New understanding of flow directions indicates that the current downgradient monitoring wells (MWs) are not optimally located. Based on the new data, installation of one additional MW northwest of SMWU 2 is recommended. The new MW would allow for more accurate assessment of the effect of contaminant releases from SWMU 2 should they occur. Previous investigation data are sufficient to meet other DQO requirements.
SWMU 3	SWMU 3 is managed under the post-closure requirements of the Paducah Site Resource Conservation and Recovery Act permit. The post-closure monitoring system will be evaluated for effectiveness. If necessary, modifications will be made to continue monitoring SWMU 3 for releases. In addition, integrity of the leachate collection system will be evaluated. Sampling locations also will be proposed for the additional area added to the SWMU in March 2003 to evaluate contaminants that may have migrated into the ditch area.
SWMU 4	During the WAG 3 investigation, the principle study questions were answered with the data collected; therefore, no additional data are necessary to complete additional FS determinations. In 2004, an investigation was initiated in accordance with the Site Investigation Work Plan for the Southwest Plume. The results obtained during this investigation will be used to optimize remedy selection.
SWMU 5	During the WAG 3 investigation, the principle study questions were answered with the data collected; therefore, no additional data are necessary to complete additional FS determinations.
SWMU 6	During the WAG 3 investigation, the principle study questions were answered with the data collected; therefore, no additional data are necessary to complete additional FS determinations.

Summary of additional data needs for the BGOU (Cont.)

SWMU	Summary of Additional Data Needs
SWMUs 7 and 30	Additional geophysical survey data are needed in the area where Drum Mountain was located. In addition, borings within this area may be needed to characterize the soil at varying depths. A radiological walk-over survey also may be needed to confirm that all hot spot areas have been identified. Anecdotal accounts of burial pits in the areas adjacent to SWMUs 7 and 30 warrant a record search, interviews, and possibly additional geophysical surveying outside the boundaries of SWMUs 7 and 30. The extent of the geophysical survey will be dependent on the information gathered in the record search and interviews. Sample collection will be guided by the results of the record search, interviews and geophysical survey.
SWMU 145	In 2001, a scoping package was prepared that included SWMU 145 as it relates to the entire C-746-S&T Landfill area (BJC 2001). The 2001 package summarized data available near this SWMU in both soil and groundwater media. The scoping package was used to develop the *Site Investigation Work Plan for the C-746-S&T Landfill at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky* (DOE 2003b). Additional data are needed to complete additional FS determinations. The C-746-S&T Landfill Site Investigation was initiated in 2004 in accordance with the above referenced work plan. Data from this investigation will be available prior to, and considered during, the BGOU RI/FS Work Plan development.

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1. INTRODUCTION

The Paducah Gaseous Diffusion Plant (PGDP), located within the Jackson Purchase region of western Kentucky, is an active uranium enrichment facility that is owned by the U.S. Department of Energy (DOE). PGDP was owned and managed first by the Atomic Energy Commission and the Energy Research and Development Administration, DOE's predecessors; DOE then managed PGDP until 1993. On July 1, 1993, the United States Enrichment Corporation assumed management and operation of the PGDP enrichment facilities under a lease agreement with DOE. DOE, however, still owns the enrichment complex and is responsible for environmental restoration activities associated with legacy operation of PGDP (CERCLIS# KY8-890-008-982). DOE is the lead agency for remedial actions, and the U.S. Environmental Protection Agency (EPA) and the Kentucky Department for Environmental Protection (KDEP) have regulatory oversight responsibilities.

Source units and areas of contamination at PGDP have been combined into five operable units (OUs) for evaluation of remedial actions. These OUs include the Surface Water Operable Unit (SWOU), the Burial Grounds Operable Unit (BGOU), the Soils Operable Unit (SOU), the Groundwater Operable Unit (GWOU), and the Decontamination and Decommissioning (D&D) OU. Each OU is designed to remediate contaminated media associated with PGDP. The SWOU is directed at remediating the surface-water bodies including the outfall ditches, impoundment ponds, and Little Bayou and Bayou Creeks. The SOU is designed to remediate the contaminated soils associated with the plant and not located in a waterway, outfall, ditch, or burial grounds. The BGOU scope addresses the contamination that is associated with the PGDP landfills and burial grounds. The GWOU will develop and implement remedial alternatives for chemicals of concern associated with the groundwater beneath and near PGDP. The scope of the D&D OU includes 17 currently inactive DOE facilities, those SWMUs and areas of concern (AOCs) designated as being associated with gaseous diffusion plant (GDP) operations as discussed above and the currently operating GDP. Once the BGOU, SWOU, GWOU, SOU, and D&D OU are completed, a Comprehensive Sitewide OU will be conducted (DOE 2000a).

The subject of this scoping document is the BGOU (SWMUs 2, 3, 4, 5, 6, 7, 30, and 145). Fig. 1.1 identifies the locations of these SWMUs in relation to PGDP. With the exception of SWMU 145, these SWMUs are located within the plant secured area.

The Scoping Document for the BGOU includes the sections outlined below.

Chapter 1: Introduction. This chapter addresses the scope of the project, as well as the objectives and goals for the scoping document, and discusses the data quality objective (DQO) process.

Chapter 2: Study Area Investigation. Chapter 2 contains descriptions of each of the SWMUs of concern and discusses the process history and previous investigations that have been conducted. This chapter also discusses possible response scenarios and additional sampling that may be required to provide a complete data set needed to make remedial action decisions.

Chapter 3: Applicability of Streamlined Response Actions. Chapter 3 provides an overview of the potential response actions that may be required as a result of evaluating existing data and obtaining additional characterization data.

Chapter 4: References. Chapter 4 presents the references cited in this document.

Appendix A: BGOU Risk Comparison Data Summary Tables. Summary of data for each SWMU that follows guidance outlined in Appendix C of the *Methods for Conducting Risk Assessments and Risk Evaluations at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky* (DOE 2000b).

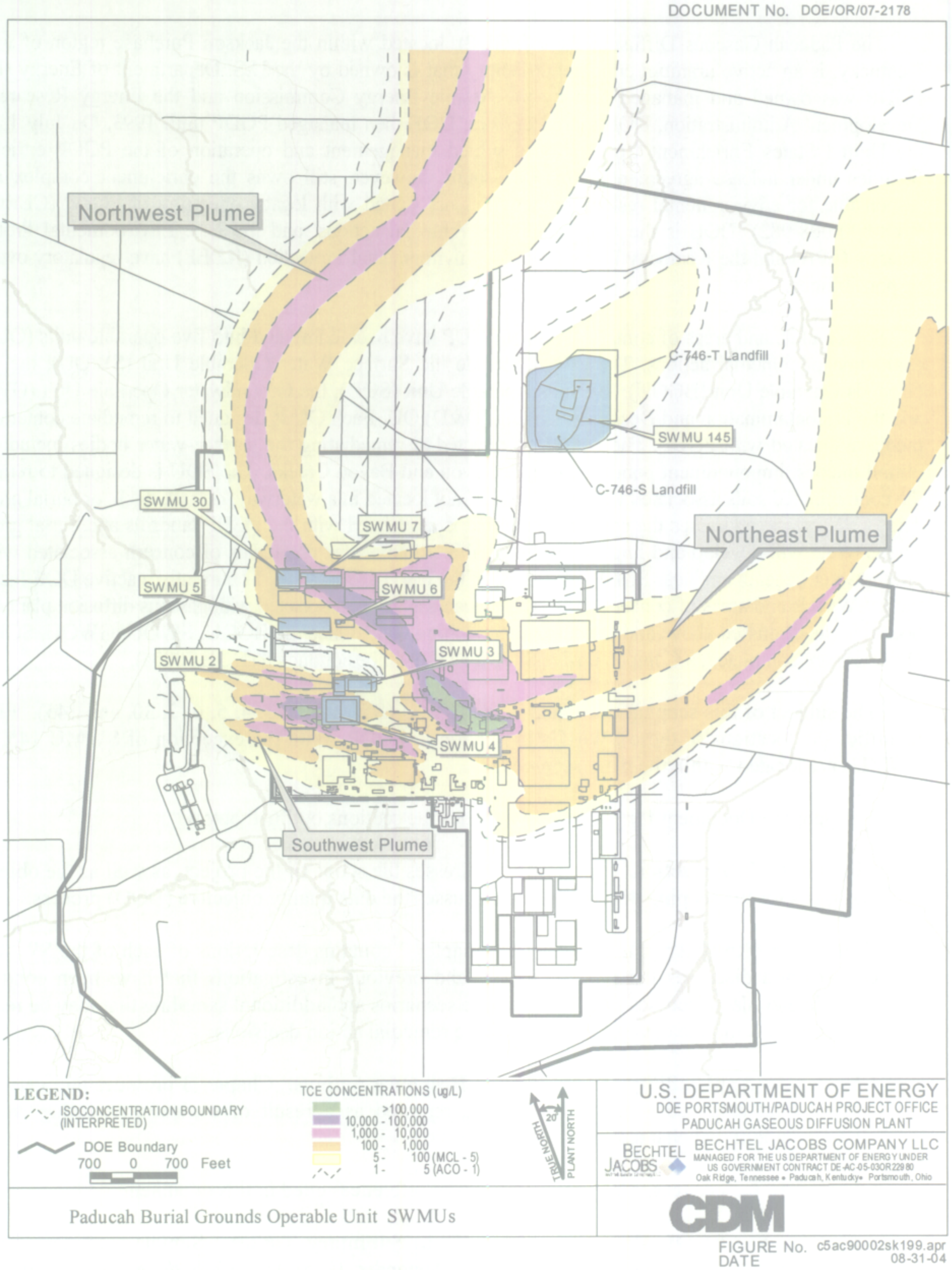


Fig. 1.1 BGOU SWMUs and groundwater plumes at PGDP

1.1 WORK PLAN SUMMARY

This Remedial Investigation/Feasibility Study (RI/FS) Scoping Document has been prepared to assist in preparation of the RI/FS Work Plan for the investigation and possible subsequent remediation of BGOU SWMUs on the PGDP. The document utilizes a compilation of sampling information collected at and around PGDP over the course of the last ten years. Data were compiled and screened against primary contaminants of concern listed in the *Methods for Conducting Risk Assessments and Risk Evaluations at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky Volume 1. Human Health* (DOE 2000b). Additional data needed, if any, will be identified and documented in the RI/FS Work Plan. The need for additional sampling will be determined consistent with sound technical principles and the *Methods for Conducting Risk Assessments and Risk Evaluations at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky Volume 1. Human Health* (DOE 2000b).

This scoping document utilizes the DQO process as a planning tool to assist in the identification of environmental problems and to define the data collection process needed to support decisions regarding the problem associated with the BGOU.

The goals for the BGOU RI/FS are consistent with those established in the Paducah Site Federal Facilities Agreement (FFA) and the Paducah Site Management Plan (SMP) negotiated among DOE, EPA, and KDEP. The FFA requires that PGDP identify, investigate, and remediate all AOCs and SWMUs that could potentially pose a threat to human health and the environment. The goals of this RI/FS are as follows:

- Goal 1: Characterize Nature of Source Zone—characterize the nature of contaminant source materials using existing data, and if required, by collecting additional data;
- Goal 2: Define Extent of Source Zone and Contamination in Soil and Other Secondary Sources at All Units—define the nature, extent (vertical and lateral), and magnitude of contamination in soils, sediments, surface water, and groundwater; determine the presence, general location (if practicable), and magnitude of any dense, nonaqueous-phase liquid (DNAPL) zones as defined in the Paducah SMP (DOE 2004);
- Goal 3: Determine Surface and Subsurface Transport Mechanisms and Pathways—gather existing, and if necessary, collect additional adequate data to analyze contaminant transport mechanisms and support a feasibility study; and
- Goal 4: Support Evaluation of Remedial Technologies—determine if the existing data are sufficient to evaluate alternatives that will reduce risk to human health and the environment and/or control the migration of contaminants off-site.

The BGOU RI/FS Work Plan will follow the outline prescribed in the FFA.

1.2 PROJECT SCOPE

The general scope of this project is to provide a document identifying the data available and the data required to conduct an RI/FS at the BGOU located within and near PGDP. The primary focus of the scoping document will be to collect existing information about contamination in and around the SWMUs and determine what additional data are required to support an assessment of risks to human health and the environment and the selection of actions to reduce these risks, if required.

Secure On-Site Source Units. For all secure on-site source units (sites within the PGDP security area), the focus of the investigation will not necessarily be bounded by the surface area of the SWMU and the water table below the unit. The focus of the investigation at these units will be soil contamination at the unit and any secondary sources from the unit located in the subsurface soil and groundwater. Collected data will be incorporated into existing groundwater computer leaching models and reevaluated.

Relationship of Source Units to the Other Operable Unit Remedial Studies. Data collected during the RI/FS will be incorporated into remedial studies of the GWOU and SWOU and used in development of facility-wide models. For groundwater, data collected on vadose-zone and Upper Continental Recharge System (UCRS) contaminant concentrations may be used in the development of the facility-wide groundwater flow and solute transport models. Incorporation of these data will allow the significant sources of groundwater contamination to be considered in the human health risk assessment of the GWOU. For surface water, data collected during the RI/FS concerning contaminant migration to the surface water operable unit may be used in the development of the facility-wide surface water transport models needed for the human health and ecological risk assessments of the SWOU.

Remedial or Removal Actions. If remedial or removal actions are implemented at any of the SWMUs addressed in this work plan before the development of a final remedy, they will be consistent with the anticipated final action for the BGOU and will contribute to the final remediation of the site. The setting under which remedial alternatives will be screened at a SWMU will be determined at the time the remedial action objectives for the BGOU are developed.

The RI/FS process is an interactive one in which EPA, KDEP, DOE, DOE contractors, and others evaluate and approve or revise work conducted during various stages of the investigation. The first stage involves implementation of the RI/FS work plan. Flexibility will be included in the sampling plans for each SWMU to allow some adjustments to be made in the field. Unexpected contaminant levels or subsurface conditions may require changes to the plans.

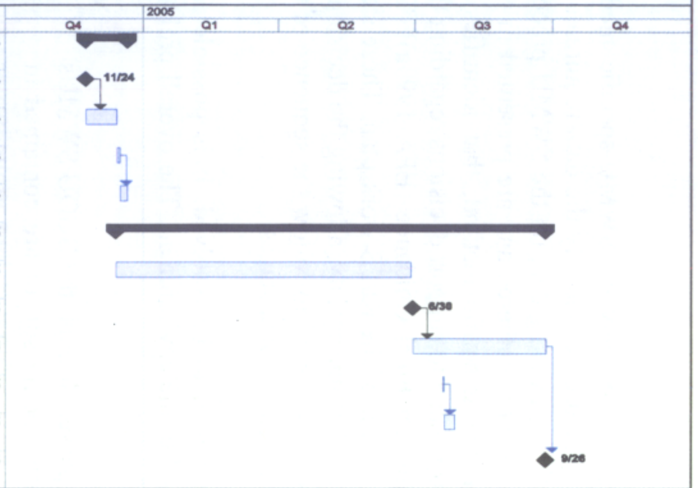
The scope includes an RI, baseline risk assessment, evaluation of remedial alternatives, remedy selection, and implementation of actions as necessary for protection of human health and the environment for the following burial grounds: C-749 (SWMU 2), C-404 (SWMU 3), C-747 (SWMU 4), C-746-F (SWMU 5), C-747-B (SWMU 6), C-747-A (SWMUs 7 and 30, which includes the area beneath SWMU 12), the residential/inert borrow area and old North-South Diversion Ditch (NSDD) disposal trench (SWMU 145), and additional disposal areas that might exist beneath the scrap yards (DOE 2004). Project uncertainties that could potentially affect the scope and schedule include the amount and scope of RI characterization needed (e.g., test pits, angular borings) and whether additional actions beyond capping will be required. The April 2004 SMP agreement established a submittal date for a D1 RI/FS work plan of June 30, 2005.

Historical records and documents will be searched to determine whether there are additional burial grounds within the BGOU. If the data indicate there are additional burial grounds, then a strategy will be developed to investigate the areas most likely to contain the burial grounds.

The project schedule in Fig. 1.2 is for estimation purposes only. Enforceable schedules and timetables for this project are set forth in Appendix C of the FFA.

BGOU Scoping Document and Work Plan Schedule

ID	Task Name	Work Days	Start	Finish
1	**Burial Ground Operable Unit (BGOU) Scoping Document**	**18 days**	**Wed 11/24/04**	**Tue 12/21/04**
2	D1 (Final) to the EPA/KY	0 days	Wed 11/24/04	Wed 11/24/04
3	Regulator Comment Review Period for D1 (Final)	13 days	Wed 11/24/04	Tue 12/14/04
4	D1 (Final) Scoping Document Review Meeting	2 days	Wed 12/15/04	Thu 12/16/04
5	D1 (Final) Scoping Document Review Meeting Minutes	3 days	Fri 12/17/04	Tue 12/21/04
6	**Burial Ground Operable Unit (BGOU) Work Plan**	**198 days**	**Tue 12/14/04**	**Mon 9/26/05**
7	Prepare D1 Work Plan	136 days	Tue 12/14/04	Tue 6/28/05
8	D1 (Final) to the EPA/KY	0 days	Thu 6/30/05	Thu 6/30/05
9	Regulator Comment Review Period for D1 (Final)	61 days	Thu 6/30/05	Mon 9/26/05
10	D1 (Final) Work Plan Review Meeting	1 day	Wed 7/20/05	Wed 7/20/05
11	Submit D1 (Final) Work Plan Review Meeting Minutes	5 days	Thu 7/21/05	Wed 7/27/05
12	Receive Comments on D1 (Final) from Regulators	0 days	Mon 9/26/05	Mon 9/26/05



Task | Progress | Summary | External Tasks | Deadline
Split | Milestone | Project Summary | External Milestone

U.S. DEPARTMENT OF ENERGY
DOE PORTSMOUTH/PADUCAH PROJECT OFFICE
PADUCAH GASEOUS DIFFUSION PLANT

BECHTEL JACOBS COMPANY LLC
MANAGED FOR THE US DEPARTMENT OF ENERGY UNDER
US GOVERNMENT CONTRACT DE-AC-05-03OR22980
Oak Ridge, Tennessee • Paducah, Kentucky • Portsmouth, Ohio

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Fig. 1.2 RI/FS Work Plan schedule

1.3 PROJECT DATA QUALITY OBJECTIVES

The DQO process will be used to focus the sampling strategy on SWMU-specific media, contamination, and migration pathways. This process also will be used to identify the data requirements for the baseline risk assessment and FS. To facilitate this activity, existing data on the SWMU process, waste management, releases, and environmental site conditions were gathered and are presented in this document. The DQO process is a planning tool, based on the scientific method, that identifies an environmental problem and defines the data collection process needed to support decisions regarding that problem [*Data Quality Objectives Process for Superfund*, Interim Final Guidance (EPA 1993a)]. The steps outlined in the DQO process will be used in the development of the RI/FS work plan. These steps will formulate a set of criteria that will achieve the desired control of uncertainty, allowing the decision to be made with acceptable confidence. In establishing DQOs, it is important to follow the sequence of the stages because the product of each stage forms the foundation for subsequent stages.

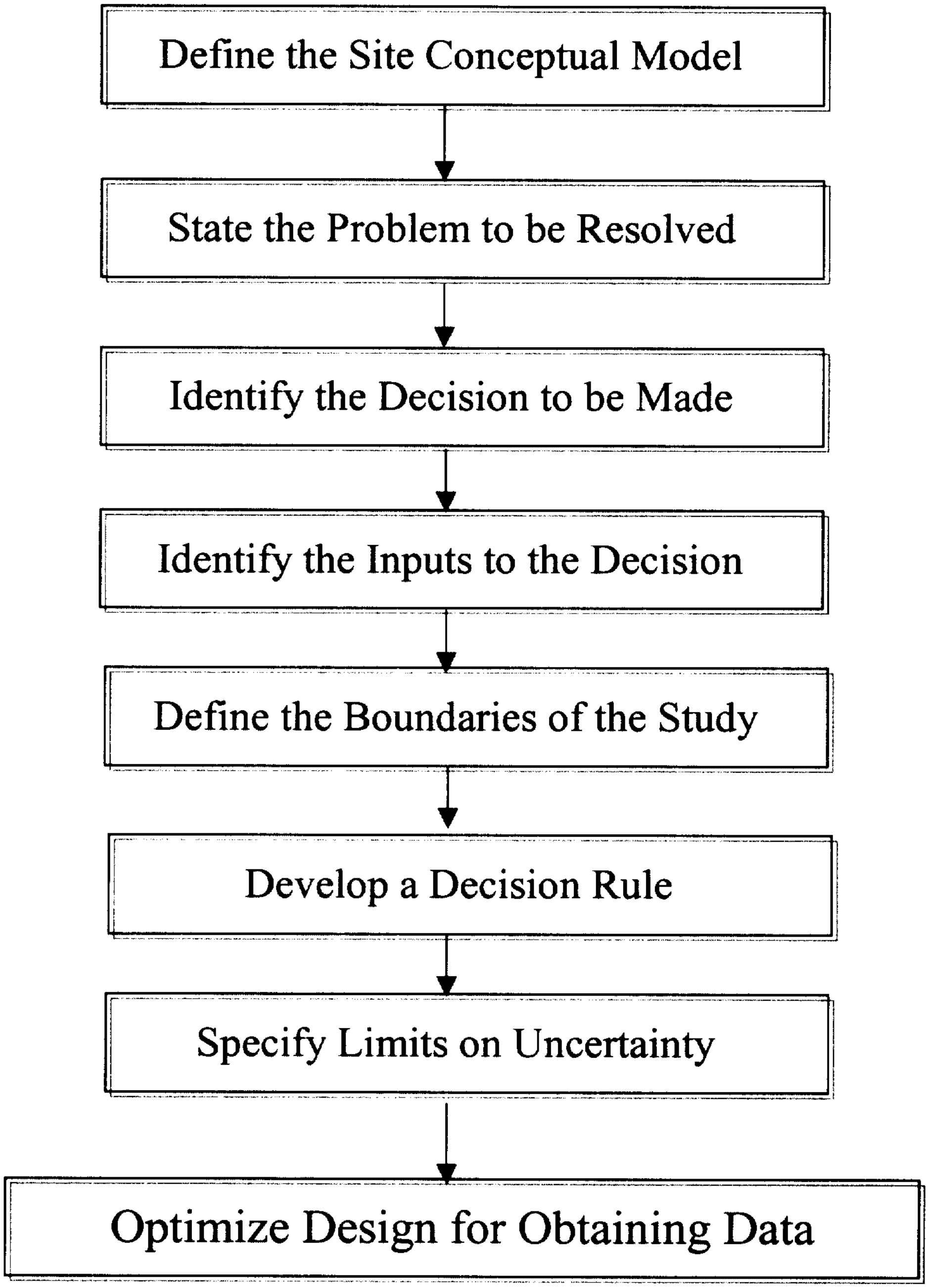
The first step in the DQO process is to identify the problem to be resolved. It is possible that contaminants originating from the SWMUs have been released to the environment. The overall problem statement developed for the DQO process is as follows.

> Hazardous substances that have been contained in or passed through the BGOU SWMUs may have been released to surface water or into surrounding soil or are contained in structural materials. These substances may, in turn, have infiltrated into groundwater below the unit and been transported through subsurface pathways. The nature and extent of contamination has been adequately defined for some SWMUs and risk assessments have been prepared. For others, the nature and extent of contamination has not been adequately defined to assess whether potential contaminants pose unacceptable risks to human health and the environment at the SWMUs and at downgradient exposure points. Data gaps should be identified so that a comprehensive RI/FS report can be prepared for the eight SWMUs within the BGOU.

The subsequent six steps in the process were completed in accordance with the above-referenced guidance (EPA 1993a) and are listed below:

- decisions to be made,
- identification of inputs to the decisions,
- definition of the boundaries of the study,
- development of a decision rule,
- development of uncertainty constraints, and
- optimization of the design for obtaining data.

Fig. 1.3 shows the DQO process chart. A conceptual site model has been developed and is demonstrated in Fig. 1.4. In order to facilitate discussion, the seven steps of the DQO process have been initiated, and a preliminary set of decision rules and questions to be answered to complete the DQO process are provided in Table 1.1. Table 1.1 states the goals and outlines the decision rules, evaluation methods, and data needs that will determine the final action undertaken at the BGOU SWMUs.



U.S. DEPARTMENT OF ENERGY
DOE PORTSMOUTH/PADUCAH PROJECT OFFICE
PADUCAH GASEOUS DIFFUSION PLANT

BECHTEL JACOBS COMPANY LLC
MANAGED FOR THE US DEPARTMENT OF ENERGY UNDER
US GOVERNMENT CONTRACT DE-AC-05-03OR22980
Oak Ridge, Tennessee Paducah, Kentucky Portsmouth, Ohio

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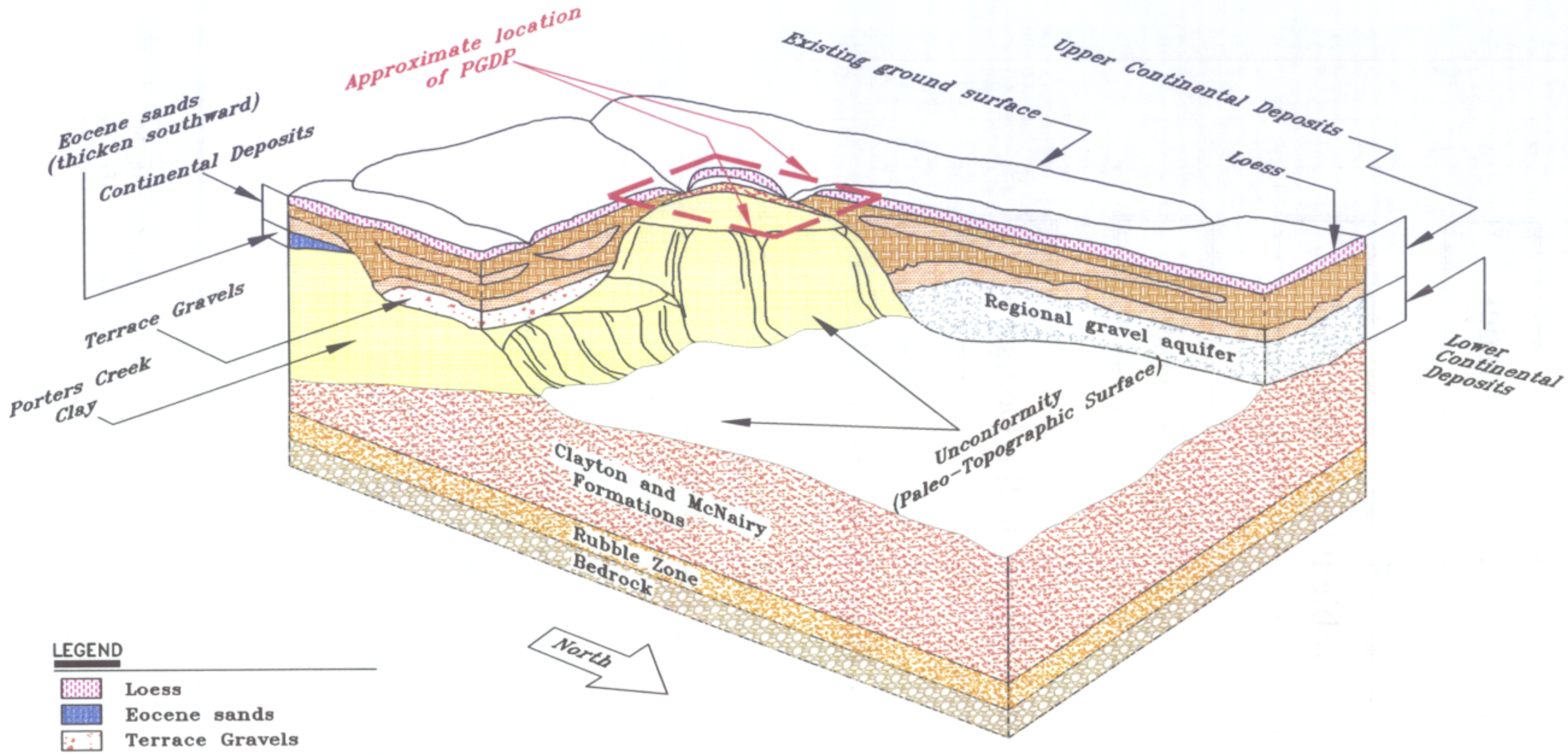
Fig. 1.3 DQO process chart



LEGEND

- Loess
- Eocene sands
- Terrace Gravels
- Clayton and McNairy Formations
- Porters Creek Clay
- Continental Deposits – Interbedded silts/clay and sand/gravel
- Regional Gravel Aquifer
- Sand
- Rubble Zone
- Bedrock

Source: Clausen et al. 1992a

Not to Scale

U.S. DEPARTMENT OF ENERGY
DOE PORTSMOUTH/PADUCAH PROJECT OFFICE
PADUCAH GASEOUS DIFFUSION PLANT

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Fig. 1.4 Conceptual model of the stratigraphy in the vicinity of PGDP

Table 1.1. Decision rules, evaluation methods, and data needs for BGOU

GOAL 1: CHARACTERIZE NATURE OF SOURCE ZONE

Decisions and questions

1-1: What are the suspected contaminants?
1-2: What are the plant processes that could have contributed to the contamination? When and over what duration did releases occur?
1-3: What are the concentrations and activities at the source?
1-4: What is the area and volume of the source zone?
1-5: What are the chemical and physical properties of associated material at the source areas?

Decision rule	Evaluation method	Data needs
D1a: If the concentration of analytes found in the source zone could result in a cumulative excess lifetime cancer risk greater than 1×10^{-6} or a cumulative Hazard Index greater than 1 through contact with contaminated media, **or** if the concentration of analytes in the source zone could result in detrimental impacts to nonhuman receptors through contact with contaminated media as indicated by exceeding ecological screening criteria, **and** if the concentrations of analytes in the source zone are greater than those expected to occur naturally in the environment, then evaluate actions that will mitigate risk; otherwise pursue a "no further action" decision (see D1b and D1c).	<u>Screening</u> Quantitative comparisons by medium between maximum detected concentrations of analytes in the source zone and preliminary remediation goals (PRGs) and background concentrations Quantitative comparison by medium between maximum detected concentrations of analytes and nonhuman receptor benchmarks <u>Baseline</u> Completion of baseline human health risk and baseline screening ecological risk assessments	Results of previous investigations and reports to target sampling locations and analytical requirements Sampling data from each medium Site use and activity history Procedures and methods for human health and ecological risk assessments of source units

Table 1.1. Decision rules, evaluation methods, and data needs for BGOU (Cont.)

Decision rule	Evaluation method	Data needs
D1b: If concentrations of analytes found in the source zone exceed applicable or relevant and appropriate requirements (ARARs), then evaluate actions that will bring contamination within the source zone into compliance with ARARs; seek an ARAR waiver; or propose/obtain alternative standards.	Quantitative comparison by medium between analyte concentrations and ARARs	Results of previous investigations and reports to target sampling locations and analytical requirements Sampling data from each medium Site use and activity history List of chemical-specific ARARs Procedures and methods for performing comparisons
D1c: If contaminants found at the site are known to transform or degrade into chemicals that could lead to increased risks to human health or the environment or into chemicals for which there are ARARs, **and** if the concentrations of these contaminants could result in risks greater than those defined in D1a or concentrations greater than ARARs, then evaluate actions that will mitigate potential future risk or obtain compliance with ARARs; seek an ARAR waiver; or propose/obtain alternative standards.	Completion of a baseline human health risk assessment that considers transformation and degradation of contaminants found in the source zone Quantitative comparison by medium between analyte concentrations and ARARs	Results of previous investigations and reports to target sampling locations and analytical requirements Sampling data from each medium Site use and activity history Analyte degradation or transformation paths List of chemical-specific ARARs Geochemical and biological parameters that could affect chemical degradation and transformation Procedures and methods for human health and ecological risk assessments and comparison with ARARs

Table 1.1. Decision rules, evaluation methods, and data needs for BGOU (Cont.)

GOAL 2: DEFINE EXTENT OF SOURCE ZONE AND CONTAMINATION IN SOIL AND OTHER SECONDARY SOURCES AT ALL UNITS

Decisions and questions

2-1: What are the past, current, and potential future migratory paths?
2-2: What are the past, current, and potential future release mechanisms?
2-3: What are the contaminant concentrations or activity gradients?
2-4: What is the vertical and lateral extent of contamination?
2-5: What is the relationship of the UCRS gradient to the source, to surface water bodies, and to the Regional Gravel Aquifer (RGA)?

Decision rule	Evaluation method	Data needs
D2a: If secondary sources are found, **and** if the concentration of analytes within the secondary source is found to potentially result in a cumulative excess lifetime cancer risk greater than 1×10^{-6} or a cumulative Hazard Index greater than 1 through contact with contaminated media at the unit, **and** if the concentrations of analytes are greater than those expected to occur naturally in the environment, then evaluate actions that will mitigate risk; otherwise do not consider secondary sources when making remedial decisions for the unit.	Screening Quantitative comparisons by medium between maximum detected concentrations of analytes and PRGs and background concentrations Quantitative comparison by medium between maximum detected concentrations of analytes and nonhuman receptor benchmark Comparison between concentrations of TCE in groundwater and analytical limits set for TCE in detection of secondary sources Baseline Completion of baseline human health and screening ecological risk assessments	Results of previous investigations and reports to target sampling locations and analytical requirements Sampling data from UCRS groundwater and potential RGA groundwater if contamination is detected in shallow groundwater Analytical limits for identification of secondary sources Subsurface characterization information including aquifer properties, stratigraphy, and horizontal and vertical conductivities

Table 1.1. Decision rules, evaluation methods, and data needs for BGOU (Cont.)

GOAL 3: DETERMINE SURFACE AND SUBSURFACE TRANSPORT MECHANISMS AND PATHWAYS

Decisions and questions

3-1: What are the contaminant migration trends?
3-2: To what area is the dissolved-phase plume migrating?
3-3: What are the effects of underground utilities and plant operations on migration pathways including ditches?
3-4: What is the role of the UCRS in contaminant transport?
3-5: What are the physical and chemical properties of the formations and subsurface matrices?

Decision rule	Evaluation method	Data needs
D3a: If contaminants are found in the source zone, **or** if secondary sources are found, **and** if these contaminants are found to be migrating or may migrate from the source zone or from secondary sources at concentrations that may potentially result in a cumulative excess lifetime cancer risk greater than 1×10^{-6} or a cumulative Hazard Index greater than 1 through use of contaminated media at downgradient points of exposure, **and** the concentrations of analytes are greater than those expected to occur naturally in the environment, then evaluate actions that will mitigate risk; otherwise do not consider risk posed by migratory pathways when evaluating remedial alternatives for the unit (see D3b).	<u>Screening</u> Quantitative comparisons by medium between modeled contaminant concentrations and PRGs and background concentrations <u>Baseline</u> Completion of a baseline human health risk assessment for exposure points located away from the unit to which contaminants may migrate	Results of analyses performed under D1a and D2a Procedures and methods for human health and ecological risk assessment of source units Current and expected land-use patterns Results of models [e.g., Multimedia Environmental Pollutant Assessment System (MEPAS), Residual Radioactive Materials (RESRAD), Seasonal Soil Compartment Model (SESOIL)] that can predict future groundwater or surface water contaminant concentrations at exposure points. Modeling parameters including groundwater flow, horizontal and vertical hydraulic conductivity, chemical parameters, mineralogy, oxidation-reduction potential, and porosity Determination of properties of UCRS and RGA groundwater that will significantly affect uranium transport and barium, iron, magnesium, sodium, potassium, chloride, phosphate, bicarbonate, alkalinity, fluoride, and dissolved silica

Table 1.1. Decision rules, evaluation methods, and data needs for BGOU (Cont.)

Decision rule	Evaluation method	Data needs
D3b: If contaminants are found in the source zone, **or** if secondary sources are found, **and** if these contaminants are found to be migrating or may migrate from the source zone or from the secondary source at concentrations that exceed ARARs, then evaluate actions that will bring migratory concentrations into compliance with ARARs; waive ARARs or obtain alternate standards; otherwise, do not consider ARARs when examining migratory pathways during the evaluation of remedial actions (see D3a).	Quantitative comparison by medium between modeled analyte concentrations at downgradient exposure points and ARARs	Results of analyses performed under D1b List of chemical-specific ARARs Current and expected land-use patterns Results of models (e.g., MEPAS, RESRAD, SESOIL) that can predict future groundwater or surface water contaminant concentrations at exposure points (Geochemical equilibria will be addressed in the RI report.) Modeling parameters including groundwater flow, horizontal and vertical conductivity, chemical parameters, mineralogy, oxidation-reduction potential, and porosity

Table 1.1. Decision rules, evaluation methods, and data needs for BGOU (Cont.)

GOAL 4: SUPPORT EVALUATION OF REMEDIAL ALTERNATIVES

Decisions and questions

4-1: What are the possible remedial technologies applicable for this unit?
4-2: What are the physical and chemical properties of media to be remediated?
4-3: Are cultural impediments present?
4-4: What is the extent of contamination (geologic limitations presented by the source zone or secondary source)?
4-5: What would be the impact of action on and by other sources?
4-6: What would the impact of an action at the source be on the integrator units?
4-7: What are stakeholders' perceptions of contamination at or migrating from source zone or secondary sources?

Decision rule	Evaluation method	Data needs
D4a: If Decision D1a, D1b, D1c, D2a, D3a, or D3b indicates that response actions are needed, then evaluate response actions to mitigate risk in the source zone.	Use of results of baseline human health risk assessment and screening ecological risk assessment to determine if action is needed Use of results of comparison of contaminant concentrations to ARARs to determine if action is needed Qualitative (or quantitative) assessment of decrease or increase in risk to human health and the environment as a result of implementation Evaluation of ARARs Evaluation of existing risk management procedures or activities currently being conducted at the site	Data listed for D1a, D1b, D1c, D2a, D3a, and D3b Methods for qualitative (or quantitative) analyses of decrease or increase in risk to human health and the environment as a result of implementation Additional physical parameters including compaction, grain size, cation exchange, thermodynamic conductivity, dielectric constants, chemical oxygen demand, pH, and moisture content of soils Total dissolved solids in groundwater List of ARARs

2. STUDY AREA INVESTIGATION

2.1 EXISTING DATA

Several documents have been produced containing data pertinent to the various SWMUs within the BGOU. In most cases, the previously prepared documents grouped several SWMUs together and did not study one particular SWMU. These documents and the various MWs installed throughout PGDP provide considerable usable data for this scoping document. Data were downloaded from the Paducah Oak Ridge Environmental Information System (OREIS) data base in July 2004. Data then were limited to the past ten years for screening purposes (BJC 2004). In addition, any previously rejected data were eliminated from the data set.

2.1.1 C-749 Uranium Burial Ground (SWMU 2)

Area Description

The C-749 Uranium Burial Ground (SWMU 2) is located within the west-central portion of the plant north of Virginia Avenue inside the security-fenced area at the PGDP as shown in Fig. 2.1. SWMU 2 encompasses an area of approximately 2,973 meters $(m)^2$ (32,000 feet $[ft]^2$) with approximate dimensions of 49 by 61 m (160 by 200 ft). Records indicate that when the burial ground was in use, pits were excavated to an estimated depth of 2.1 to 5.2 m (7 to 17 ft). After the burial ground was no longer in use, the area was covered with a 15.2-centimeter (cm) (6-inch [in]) thick clay cap and a 45.6-cm (18-in) thick soil layer covered with vegetation (DOE 1995).

Process History

SWMU 2 was used from 1951 to 1977 for the disposal of uranium and uranium-contaminated wastes. Disposal records for SWMU 2 indicate that 245,000 kilograms (270 tons) of uranium, 223,000 liters (L) (59,000 gallons [gal]) of oils, and 1,700 L (450 gal) of trichloroethene (TCE) were disposed of in the unit (DOE 1999b). Disposal records also indicate that drummed wastes buried in the unit consist primarily of uranium metal from machine shop turnings, shavings, and sawdust. Other wastes at the unit consist of drummed uranyl fluoride and TCE. Because small pieces of uranium metal may be pyrophoric (spontaneously burn in air), operating practices of that time were to place the material in drums and submerge the material in petroleum-based oil and synthetic oil to avoid contact with air.

Most of the waste in the unit is believed to consist of pyrophoric uranium metal in the form of machine shop turnings, shavings, and sawdust. Pyrophoric uranium metal usually was placed in 20-, 30-, or 55-gal drums. Occasionally, fires were reported as a result of oxidation of pyrophoric uranium metal, but no subsidence has been observed as a result of volume reductions due to the fires. It is possible that the oils used may have included some polychlorinated biphenyls (PCB)-contaminated oils. Other forms of uranium, including oxides of uranium (solid and dissolved in aqueous solutions), uranyl-fluoride solutions, uranium-zirconium alloy, slag, and uranium tetrafluoride, were buried in small quantities (DOE 1996).

The most likely scenario is that the uranium buried at PGDP is in the metallic state or is coated with uranium (U) (IV) oxide. Neither of these forms of uranium is very susceptible to leaching. The kinetics of dissolution of the buried metal and U (IV) oxide is controlled by the amount of oxygen and carbon dioxide that leaches through the waste. Site records show that much of the metal was coated with oil, in many cases, PCB-oil. Such oils are resistant to chemical and biological attack and from leaching by percolating waters. In addition, oils, as they slowly degrade, consume oxygen, which lowers the oxidation-reduction potential. Under such conditions uranium dissolution is negligible (ORNL 1998).

No documentation of technetium-99 (^{99}Tc) disposal at SWMU 2 exists. However, during the years of feed plant operation from 1953 to 1964 and from 1968 intermittently through 1977, partially depleted reactor tails were reprocessed through the feed plant, resulting in the introduction of reactor-produced radioactive impurities, such as ^{99}Tc into the enrichment process. It is possible that a portion of the uranium-contaminated wastes disposed in burial grounds at PGDP contains ^{99}Tc from reprocessing activities. This assumption is supported by the detection of ^{99}Tc in groundwater samples taken from MWs near the SWMU 2. (DOE 1994)

Materials contaminated with TCE also are known to have been disposed of at SWMU 2. In August 1984, Area 9 of SWMU 2 was excavated due to concern about the integrity of TCE-containing drums (fifteen 30-gal drums) reportedly disposed in this area. Little documentation is available concerning this excavation. However, it is reported that during excavation, four 30-gal drums and thirty-five 55-gal drums (thirty of these drums contained uranium sludges, not TCE) were recovered; some of these drums were in poor condition. Some drums found were not on the original listing as buried in that area (DOE 1995). The material was left within the SWMU and re-covered.

Previous documents that included information from investigations in the area surrounding SWMU 2 were completed in 1995, 1996, 1997, 1998, and 2003. In addition, data is continually collected from MWs positioned throughout the PGDP to track plume movement.

Surface Water Hydrology

The SWMU 2 and SWMU 3 sites combined are approximately 2.02 hectares (5 acres) in size. SWMU 2 is slightly mounded, with surface elevations ranging between 113 and 114 m (370 and 377 ft) above mean sea level (amsl). Ditches to the north and south of SWMU 2 and SWMU 3, and to the east of SWMU 3, are approximately 0.6 to 1.8 m (2 to 6 ft deep). These ditches discharge through KPDES Outfall 015 to Bayou Creek.

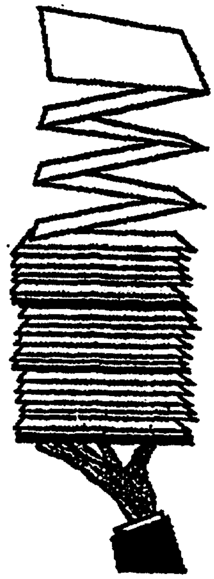
The surface of the SWMU and the surrounding ditches are grass-covered, except for areas of gravel pads placed during previous investigations for drill rig access. Discharge through Outfall 015 includes surface runoff from the west central plant area. Flow through the outfall is erratic in response to rainfall events (DOE 1994).

Stratigraphy

Surficial deposits within the area surrounding SWMU 2 consist of 5 to 6 m (16 to 20 ft) of lean clay. The surficial deposits are included in the Henry Silt Loam soil series and consist of silt loam and silty clay loam. These soils are poorly drained, with water standing at the surface during wet periods. A low-permeability layer (fragipan) is typically present at depths ranging from 0.3 to 1.2 m (1 to 4 ft) below ground surface (bgs) and is 0.3 to 0.6 m (1 to 2 ft) thick. Because the fragipan restricts vertical drainage, water typically perches on this layer during the winter and spring, causing a seasonally high zone of saturation near the surface. Excavation beneath the burial mounds has probably disturbed the fragipan layer, resulting in higher vertical flow potential of water and leachate. (DOE 1994).

Results from the double-ring infiltrometer tests conducted on surface soils at SWMU 2 confirm that a 12.7-cm (6-in) clay cap exists at this SWMU. The unit was capped in 1982 with a 12.7 cm (6 in) clay cap with a permeability of 1.1×10^{-7} cm/s (2.8×10^{-4} ft/day) and an 0.5 m (18-in) thick topsoil to promote vegetative cover.

The Upper Continental Deposits underlying these surface soils are encountered at an elevation of 107 to 109 m (351 to 358 ft) amsl, at a depth of approximately 4 to 6 m (13 to 20 ft) bgs. The unit ranges in thickness from 13 to 19 m (42 to 62 ft) near SWMU 2. The typical soil type is sandy clay with interlayers of sand at various depths.



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The Lower Continental Deposits are approximately 6 to 9 m (20 to 30 ft) thick with the top elevation at 95 to 96 m (310 to 315 ft) amsl near SWMU 2. The lithology is predominantly well-rounded chert gravel with sand. Based on previous PGDP subsurface investigations, the gravel is underlain by the McNairy Formation at elevations of 82 to 85 m (270 to 280 ft) amsl.

The stratigraphy is summarized in the Lithologic Database presented in Appendix 3B of the Phase II Report (CH2M HILL, 1992).

Hydrology

The current conceptual model of the groundwater hydraulics within the UCRS shows groundwater flow primarily downward. This downward flow is via interconnected sand lenses within the UCRS and is driven by the vertical gradients, which are much greater than the horizontal gradients. The effective lateral extent of horizontal gradients is difficult to define due to the lenticular nature of these sand deposits.

The horizontal gradient in the RGA is approximately 0.00027 m/m (ft/ft) towards the north. Assuming an effective porosity of 0.2, the calculated flow velocity within the RGA at SWMU 2 was estimated to be approximately 3.8×10^{-5} cm/s (0.1 ft/day). Due to the low hydraulic gradient, actual flow directions may be governed by other factors such as localized changes in material types and anisotropy (CH2M Hill, 1992). Because SWMU 2 is located over ancestral river channel deposits that underlie the PGDP, flow may follow a preferred east-west orientation.

Additional Action or Sampling

To date, the only Record of Decision (ROD) that has been completed for the BGOU SWMUs is the *Record of Decision for Interim Remedial Action at Solid Waste Management Units 2 and 3 of Waste Area Group 22 at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky (DOE 1995).* In August 2000, a Five-Year ROD Review was conducted and found that the SWMU 2 interim ROD action is meeting the intended objectives and protecting human health and the environment. The current groundwater data indicated that assumptions underlying the remedy selection in the ROD are still valid. The recent data demonstrate that SWMU 2 is a relatively small contributor to groundwater contamination in the area. While TCE remains at concentrations above drinking water maximum contaminant limits, the existing institutional controls, environmental monitoring, and site maintenance activities at the unit continue to protect human heath and the environment. Although the monitoring assessment indicates that the current assessment of groundwater flow direction at SWMU 2 is not consistent with the initial assumption of northerly flow, protectiveness has not been compromised. The contaminant concentrations found in the MWs in and around SWMU 2 are consistent with expectations at the time of the ROD implementation, and no new contaminants or routes of exposure have been identified. However, the new understanding of flow directions indicates that the current downgradient MWs are not optimally located. Based on the new data, installation of one additional MW northwest of SMWU 2 is recommended. The new MW would allow for more accurate assessment of the effect of contaminant releases from SWMU 2. (DOE 2000a).

2.1.2 C-404 Low-Level Radioactive Waste Burial Ground (SWMU 3)

Area Description

The C-404 Low-Level Radioactive Waste Burial Ground (SWMU 3) is approximately 0.49 hectares (1.2 acres) located in the west-central portion of the secured area as shown in Fig. 2.2. The unit was originally constructed as a rectangular aboveground surface impoundment measuring 118 m by 42 m (387 ft by 137 ft) with a floor area of approximately 4,924 m^2 (53,000 ft^2). The floor of the surface impoundment was constructed of well-tamped earth, and clay dikes to a depth of 1.8 m (6 ft). The C-404 impoundment was designed with an overflow weir at its southwest corner. From the weir, the surface impoundment effluent flowed west in a ditch (not the NSDD) and eventually discharged at KPDES Outfall 015. The same cross section is used for SWMUs 2 and 3 due to similar hydrology and stratigraphy.

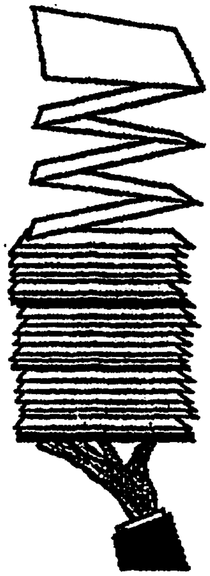
In March 2003, an additional 3,437 m^2 (37,000 ft^2) of area were added to the SWMU when a ditch area, which ran northeast-southwest and just east of SWMU 3, was included as part of the SWMU. This ditch was impacted by the discharge of a now-abandoned pipeline with historic leachate flow into the NSDD (DOE 2003a). When the C-404 impoundment was converted into a disposal facility, a sump was installed at the weir. The sump was used to pump leachate into an underground transfer line. The transfer line discharged into a ditch, which ran northeast-southwest and just east of C-404. From this ditch, the leachate flowed into the NSDD. A partial clay cap was installed on the eastern end of the landfill in 1982. The date of termination of the leachate discharge via the underground transfer line to the NSDD has not been determined. However it is known that, prior to landfill closure in 1986, this underground transfer line to the NSDD was not in operation, and leachate from the C-404 Landfill was being collected in the sump for treatment at C-400. The wastewater from the treatment of the leachate was discharged to C-403 and, ultimately, to the NSDD. At some time following closure of C-404 Landfill, treatment of leachate from C-404 at C-400 was discontinued and treatment of the leachate was transferred to C-752.

Process History

SWMU 3 operated as a surface impoundment from approximately 1952 until early 1957. During this time, all influents to the impoundment originated from C-400. In 1957, the C-404 surface impoundment was converted to a solid waste disposal facility for solid uranium-contaminated wastes. The waste consists of uranium precipitated from aqueous solutions, uranium tetrafluoride, uranium metal, uranium oxides, and radioactively contaminated trash. There are no records documenting the cleanout of sludges and sediments from the pond when it was converted to a landfill. When the C-404 impoundment was converted into a disposal facility, a sump was installed at the weir. The sump was used to pump leachate into an underground transfer line. The transfer line discharged into a ditch, which ran northeast-southwest and just east of C-404. From this ditch, the leachate flowed into the NSDD. The upper tier of wastes contains the same type of wastes that were collected in the impoundment plus smelter furnace liners and drums of extraction procedure characteristically hazardous waste (Resource Conservation and Recovery Act [RCRA] waste codes D006, D008, and D010). A partial clay cap was installed on the eastern end of the landfill in 1982 (DOE 1987).

Approximately 3,000,000 kg (6,615,000 lb) of uranium-contaminated wastes were disposed of at SWMU 3. The total volume is approximately 7,362 m^3 (260,000 ft^3). Some uranium-contaminated waste is also contaminated with TCE, radionuclides, and metals. In 1986, the disposal of any waste at C-404 Landfill was halted, and a portion of the disposed waste was found to be RCRA hazardous. The landfill was covered with a RCRA multilayered cap and certified closed in 1987. It is currently regulated under RCRA as a land disposal unit and is required to comply with a RCRA post-closure permit issued in 1992. This closure plan requires continued groundwater monitoring (DOE 1989).

The date of termination of the leachate discharge through the underground transfer line to the NSDD has not been determined. However it is known that, prior to landfill closure in 1986, this underground transfer line to the NSDD was not in operation, and leachate from the C-404 Landfill was being collected in the sump for treatment at C-400. The wastewater from the treatment of the leachate was discharged to C-403 and, ultimately, to the NSDD. At some time following closure of the C-404 Landfill, treatment of leachate from C-404 at C-400 was ceased and treatment of the leachate was transferred to C-752.



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Previous documents that included information from investigations in the area surrounding SWMU 3 were completed in 1995, 1996, 1997, 1998, and 2003. In addition, data are continually collected from MWs positioned throughout the PGDP. Because SWMU 3 is closed with a RCRA cap and is being addressed by RCRA post-closure permit requirements, SWMU 3 was not addressed in the *Record of Decision for Interim Remedial Action at Solid Waste Management Units 2 and 3 of Waste Area Group 22 at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky* (DOE 1995).

Additional Data Needs

SWMU 3 is managed under the post-closure requirements of the Paducah Site RCRA permit. Primary monitoring is for releases of contaminants into the groundwater. Because this unit lies above the existing TCE plume at PGDP, interferences from non-SWMU 3 contaminants make the data from the current MW network difficult to interpret related to SWMU 3. The post-closure monitoring system will be evaluated for effectiveness. If necessary, modifications will be made to continue monitoring SWMU 3 for potential releases. In addition, integrity of the leachate collection system will be evaluated. Sampling locations also will be proposed for the additional area added to the SWMU in March 2003 to evaluate contaminants that may have migrated into the ditch area.

2.1.3 C-747 Contaminated Burial Yard (SWMU 4)

Area Description

The C-747 Contaminated Burial Yard (SWMU 4) is located in the western section of the plant area. SWMU 4 (which covers an area of approximately 26,635 m^2 [286,700 ft^2]) is bounded on the north by Virginia Avenue, on the east by 6th Street, on the west by 4th Street, and on the south by an active railroad spur. Fig. 2.3 shows the SWMU 4 location. This SWMU is an open grass field that at one time was used for the burial and disposal of various waste materials in designated burial cells. There have not been any permanent structures built on the site. A short, narrow, gravel road that enters from 4th Street is nearly completely grass covered. Except for this rarely used road, the entire site is covered with a variety of field grasses and clovers. The site is typically mowed once a month from April through September. SWMU 4 is bounded on three sides (north, east, and west) by shallow drainage swales that direct surface runoff to the northwest corner of the site. There is an elevation difference of approximately 3.05 m (10 ft) between the highest point in the SWMU to the adjacent drainage swales. The entire burial yard was covered with 0.6 to 0.9 m (2 to 3 ft) of soil material and a 15-cm (6-in) clay cap was placed over the area in 1982 (DOE 1998b).

Process History

The C-747 Burial Yard was in operation from 1951 to 1958 for the disposal of radiologically contaminated and uncontaminated debris originating from the C-410 uranium hexafluoride feed plant. SWMU 4 also may have received sludges designated for disposal at the C-404 burial grounds. The source of these sludges is unknown, but the WAG 3 RI Work Plan (DOE 1998b) indicated that the sludges potentially included uranium-contaminated solid waste and ^{99}Tc -contaminated magnesium fluoride. The total volume of material disposed of at this site is unknown. Potential contaminants associated with this SWMU include uranium, ^{99}Tc, metals, and TCE (DOE 1998b).

In the fall of 1999, employee interviews led to a re-classification of the C-747 Burial Yard. Access was subsequently restricted based on security considerations. Also during the fall of 1999, a small (0.9 m across and 0.9 m deep [3 ft across and 3 ft deep]) sinkhole developed in the southern burial cell. The sinkhole was subsequently back-filled with soil.

Stratigraphy

Three primary units are encountered in the subsurface at SWMU 4. These are, in ascending order: the McNairy Formation, the RGA, and the UCRS. The McNairy Formation is predominantly gray lignitic clays and silts that subcrop at approximately 31 to 37 m (100 to 120 ft) bgs. The McNairy sediments are overlain by 12 to 18 m (40 to 60 ft) of porous and permeable, coarse-grained sands and chert gravels of the RGA. The RGA is in turn overlain by a fining-upward sequence of gravels, sands, silts, and clays that comprise the UCRS. Sands and gravels within the UCRS are typically fine-grained, poorly sorted, and occur as laterally discontinuous lenses within a matrix of finer-grained material (DOE 2000c).

The stratigraphy generally follows the conceptual model presented with the notable exception that the base of the RGA dips down on the western edge of SWMU 4. This results in a thickening of the RGA in this area.

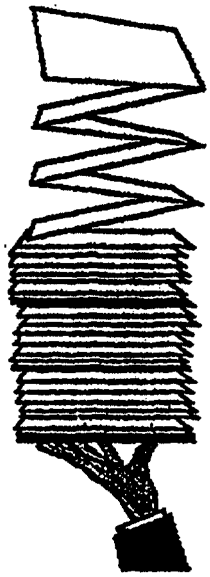
The physical and chemical properties of the subsurface soil and the depth to the water table at SWMU 4 play an important role in the migration and distribution of contaminants in the subsurface. The most common contaminants identified at the SWMU are volatile organic compounds (VOCs), radiological contaminants, PCBs, and metals. The downward mobility of metal ions would be expected to be inhibited by the low permeability of the clay-rich UCRS soil and by absorption processes. However, the UCRS sediments are not an aquiclude, and leaching of contaminants and downward migration of precipitation toward the RGA, although retarded, would be expected to be a contaminant dispersion pathway at each of the sites investigated. Because most of the UCRS sediments are within the vadose zone and because of the lack of laterally continuous sands within the UCRS, conduits for long-distance lateral migration of contaminants in the shallow subsurface would not be expected to be a significant contaminant distribution process.

Downward migrating contaminated fluids that reached the RGA would then be incorporated into the RGA groundwater and transported laterally to the west-northwest as part of the Southwest and/or Northwest Plume. Because the McNairy Formation has a lower permeability than the overlying RGA sediments, and because groundwater flow typically will follow the path of least resistance, mixing of the contaminated RGA groundwater in the off-site plumes with the deeper McNairy flow system has not been extensive. As a result, McNairy groundwater samples collected during the WAG 3 RI were found to be relatively uncontaminated (and the limited contamination that was found does not appear to be attributable to the WAG 3 SWMUs).

Previous Investigation Conclusions

SWMUs 4, 5, and 6 were investigated as part of a RI Report prepared for WAG 3 in 2000 (DOE 2000b). Prior to the WAG 3 investigation, SWMU 4 was investigated in 1992 (CH2M HILL 1992), however, no groundwater samples were collected as part of this SWMU 4 investigation. During the WAG 3 RI, one well was sampled, and several wells associated with other SWMUs in the vicinity were sampled. The WAG 3 RI Report concluded that volatiles are present in the subsurface soil, UCRS groundwater, and RGA groundwater at SWMU 4. The majority of VOCs detected were TCE and its degradation products.

Contaminants at SWMU 4 are buried in several burial cells of varying size to a depth of approximately 5 m (16 ft) bgs. Some of these contaminants may have leached out of the burial cells and into the underlying soils and groundwater. These contaminants include TCE and degradation products and various radiological contaminants. PCBs are found at shallow depths 0.9 to 1.8 m (3 to 6 ft) bgs and may be the result of waste handling practices.



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Limited data within the burial cells were collected due to the high hazards (both chemical and radiological) that were encountered. The few samples collected indicated the presence of radiological contaminants, PCBs, and various VOCs.

TCE contamination is present in soils at depths ranging from 3 to 18 m (10 to 60 ft) bgs (top of the RGA). In addition, both the shallow UCRS groundwater and the RGA are contaminated. The highest concentration of TCE was 41,000 μg/kg in the RGA and 23,000 μg/kg in the UCRS.

Radiological contamination is also widespread in SWMU 4. Alpha activities up to 3,076.71 pCi/g and beta activities up to 3,253.97 pCi/g are present. Measured radioisotopes including total uranium (up to 6260 pCi/g), ^{99}Tc (up to 269 pCi/g), and plutonium-239 (up to 4.17 pCi/g) are found in the surface and subsurface soils, and in the shallow groundwater.

PCBs were detected in surface soils (ditches) and the shallow subsurface soils at SWMU 4. All of the samples with concentrations above screening levels are contained within an area from surface to 3.4 m (11 ft) bgs.

Associated chemical and physical properties of the source areas consist of various industrial wastes and soil backfill in the burial cells, and sands, silts, and clays of the UCRS in the remainder of the SWMU. The entire SWMU is covered with a cap consisting of approximately 0.9 m (3 ft) of soil with a vegetative cover (DOE 2000c).

Additional Data Needs

In 2004, an investigation was initiated in accordance with the Site Investigation Work Plan for the Southwest Plume at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky (DOE 2003c). The problem statement for this unit reads as follows.

> *Hazardous substances, including VOCs and radionuclides, have been detected above maximum contaminate limits in the subsurface soils and groundwater within and immediately adjacent to the boundaries of SWMU 004. It is unknown if or how much contamination is entering the RGA from this unit.*

The principal study questions for this unit are these:

What are the VOCs and their concentrations in the RGA upgradient (east) of SWMU 004?

What are the VOCs and their concentrations in the RGA downgradient (west) of SWMU 004?

What are the ^{99}Tc activities in the RGA upgradient (east) of SWMU 004?

What are the ^{99}Tc activities in the RGA downgradient (west) of SWMU 004?

The results obtained during this investigation will be utilized during preparation of the BGOU RI/FS work plan to determine if any additional sampling is necessary for this unit.

2.1.4 C-746-F Burial Yard (SWMU 5)

Area Description

The C-746-F Burial Yard is located in the northwestern section of the PGDP secured area. SWMU 5 (which covers an area of approximately 18,339 m^2 [197,400 ft^2]) is located adjacent to the C-746-P Clean Scrap Yard to the north, Ditch 001 on the south, SWMU 6 to the east, and Patrol Road 1 to the west. Fig. 2.4 shows the location of SWMU 5. Disposal pits were located on a grid system consisting of 3 by 3 m (10 by 10 ft) cells excavated to a depth of 1.8 to 4.6 m (6 to 15 ft) bgs. Waste placed in the yard disposal pits was covered with 0.6 to 0.9 m (2 to 3 ft) of soil. SWMU 5 is fenced to limit access to authorized personnel only. The ground surface is covered with short grasses and various flowering herbaceous plants (DOE 1998b).

Process History

SWMU 5 was in operation from 1965 to 1987. The burial pits were used for the burial of components from the "Work for Others" activities, some radionuclide-contaminated scrap metal, and slag from the nickel and aluminum smelters. Metals and radioisotopes are the primary potential contaminants of interest at this SWMU. The total quantity of wastes buried at the yard is unknown. Chemically unstable or incompatible compound/metal wastes are thought to have been placed here also. This conclusion is supported by the occurrence of an underground fire (thought to have occurred circa 1975–1976) in the southeast corner of the yard. This fire burned for several weeks, and individuals observing the fire reported that the ground surface appeared to become unstable. The source and/or cause were never determined, and the fire extinguished itself without intervention. No data related to contaminant releases from the fire are available.

Previous Investigation Conclusions

During investigation activities in the early 1990's at SWMU 5, subsurface soil samples were collected, and an additional groundwater MW was installed. The samples collected during the WAG 3 RI and during the 1991 and 1992 investigations indicate that contamination of surface soil is minimal.

Waste at SWMU 5 is buried in several burial cells of varying size to a depth of approximately 4.6 m (15 ft bgs). Only sporadic and widely spaced contaminants were detected, including some PCBs, polycyclic aromatic hydrocarbons (PAHs), pesticides and herbicides, in shallow soils. No data within the burial cells were collected, due to the nature of the wastes (DOE 2000c).

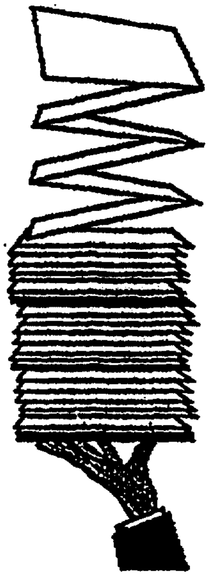
Radiological contamination was limited to a few occurrences of ^{99}Tc (ranging from 4.2 to 5.85 pCi/g). There is no evidence that this contamination is widespread, so no estimate of volumes of contaminated areas is offered.

PCBs were found in limited surface and shallow subsurface soils. The concentrations ranged from 35 to 306 μg/kg. There is no evidence that this contamination is widespread, so no estimate of volumes of contaminated areas is offered.

Pesticides, herbicides, and PAHs were found in approximately five surface and shallow subsurface soil samples. Because these samples are above the expected level at which the wastes were buried, and because the nature of these contaminants is inconsistent with what is known about the buried material (i.e., components from the "Work for Others" activities and metal slag), it is unlikely that these contaminants are associated with the burial cells. No estimate of volumes of contaminated areas is offered.

Associated chemical and physical properties of the source areas consist of various industrial wastes and soil backfill in the burial cells, and sands, silts, and clays of the UCRS in the remainder of SWMU 5. The entire SWMU is covered with a cap consisting of approximately 0.9 m (3 ft) of soil with a vegetative cover.

Potential current and future migratory paths for SWMU 5 are restricted to material in the burial cells leaching out of the bottoms of the cells and migrating generally downward to the RGA. Because no significant levels of contaminants were found, it is presumed that no releases have occurred, and no migration of contaminants is taking place.



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Surface water bodies are not likely impacted by contamination at SWMU 5 because of the lack of a pathway for contamination and the absence of surface contamination (DOE 2000b).

Additional Data Needs

During the WAG 3 investigation, the principle study questions were answered with the data collected; therefore, no additional data are necessary to complete additional FS determinations.

2.1.5 C-747-B Burial Ground (SWMU 6)

Area Description

The C-747-B Burial Ground is located in the northwestern section of the plant area east of SWMU 6. SWMU 6 was in operation from 1960 to 1976. Fig. 2.5 shows the location of SWMU 6.The entire burial area covers an area of approximately 1,254 m^2 (13,500 ft^2), which is divided into five separate burial cells (Areas H, I, J, K, and L). Dimensions of each of the cells are as follows:

- Area H - This disposal site covers an area of about 3.7 by 4.6 m (12 by 15 ft) and is about 1.8 m (6 ft) deep. A 0.9 m (3 ft) cover of soil was placed on top of the buried drums.
- Area I - This discard pit is approximately 2.4 by 10.7 m (8 by 35 ft) and is about 2.4 m (8 ft) deep. The waste was covered with about 1.5 m (5 ft) of soil.
- Area J - This burial site is about 372 m^2 (4,000 ft^2) (11.3 by 33.5 m [37 by 110 ft]) and was excavated to a depth of about 1.8 m (6 ft). The area was covered with about 0.9 m (3 ft) of soil.
- Area K - This disposal site consists of an area of about 3.7 by 4.6 m (12 by 15 ft) and is about 1.8 m (6 ft) deep. A 0.9 m (3 ft) cover of soil was placed on top of the buried drums.
- Area L - This burial area is about 6.1 by 9.1 m (20 by 30 ft) and about 1.8 m (6 ft) deep. The disposed waste was covered with about 0.9 m (3 ft) of soil.

This area is relatively flat and is bounded to the north by a set of abandoned railroad tracks, to the east by a 1.5-m-wide by 1.2-m-deep (5-ft-wide by 4-ft-deep) drainage ditch that drains into Ditch 001, and unnamed gravel roads to the west and south. The ground surface is medium to tall grasses (up to 0.9 m [3 ft] high) with occasional pockets of young trees and shrubs (DOE 1998b).

Process History

Each of the burial cells was used for the disposal of a different waste. Each cell and its contents were identified in the WAG 3 RI Report (DOE 2000c) as follows:

- Area H - Magnesium Scrap Burial Area. The scrap buried at this location is magnesium in various shapes generated in the machine shop. A total of about 10 drums of scrap were buried during midsummer 1971.

- Area I - Exhaust Fan Burial Area. Eight exhaust hood blowers removed from C-710 were discarded to this pit. These blowers, which were about 0.4 m (15 in) in diameter and weighed about 45.4 kg (100 lb) each, were discarded in 1966 because of contamination with perchloric acid. Each blower was spaced about 1.2 m (4 ft) apart in the hole.

- Area J - Contaminated Aluminum Burial Area. The contaminated scrap buried in this hole involved about 100 to 150 drums of aluminum scrap in the form of nuts, bolts, plates, trimmings, etc., which were generated in the converter and compressor shop. This scrap was buried about 1960 or 1962.

- Area K - Magnesium Scrap Burial Area. The scrap buried at this location is magnesium in various shapes generated in the machine shop. A total of about 20 drums of scrap was buried on September 3, 1968, and December 23, 1969.

- Area L - Modine Trap Burial Area. A single contaminated modine trap was buried in this area. The cold trap was about 1.2 m (4 ft) in diameter, approximately 4.6 m (15 ft) long, and weighed about 2268 kg (5000 lb). This equipment was buried on March 5, 1969.

In the WAG 3 RI Report (DOE 2000c), it was stated that approximately 50% of the surface area of SWMU 6 has been used to store radioactively contaminated equipment and materials. These items include industrial forklifts and transport carts, flatbed trailers, generators, concrete pipes, and other miscellaneous items. This equipment storage area was inaccessible during the investigation except through the use of angled drilling and sampling techniques (DOE 2000c).

Previous Investigation Conclusions

The WAG 3 RI concluded that there are no distinct patterns of contamination that might indicate widespread contamination from SWMU 6. Potential contaminants associated with SWMU 6 surface and subsurface soils are metals and radionuclides. At the time of the WAG 3 RI, the primary concern for UCRS groundwater was radiological constituents, including uranium-235, uranium-238, neptunium-237, thorium-234, and ^{99}Tc. Other potential contaminants in UCRS groundwater are acetone, TCE, and metals. The primary contaminants in the RGA groundwater were TCE and ^{99}Tc, but due to the proximity of SWMU 6 to the Northwest Plume, the presence of these contaminants is expected.

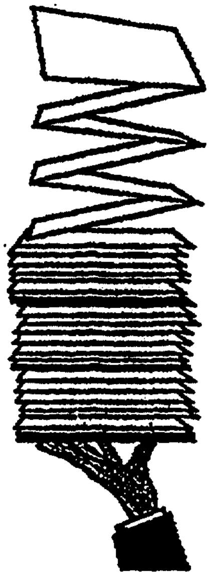
Contaminants at SWMU 6 are buried in several burial cells of varying size to a depth of approximately 1.8 m (6 ft) bgs. Only sporadic and widely spaced contaminants were detected, including some semivolatile organics compounds (SVOCs), metals, and radioisotopes in shallow soils, and some PCBs and radioisotopes in groundwater. Limited data collected within the burial cells indicated the presence of radioisotopes and PCBs.

Radiological contamination was limited to a few occurrences of ^{99}Tc, neptunium-237, and thorium-234 (ranging from 0.125 to 8.51 pCi/g). There is no evidence that this contamination is widespread, so no estimate of volumes of contaminated areas is offered.

PCB-1016 was detected in the UCRS groundwater samples from two of the soils borings. The concentrations were 53 μg/L (006-012) and 255 μg/L (005-011). Assuming the burial cell to be 34 × 11 × 1.8 m (110 × 37 × 6 ft) deep, a conservative estimate for the contaminated area is 691 m^3 (24,420 ft^3).

SVOCs were detected in two surface samples in a drainage ditch/swale located east of the SWMU. Because these samples are above the expected level at which the wastes were buried, and because the nature of these contaminants is inconsistent with what is known about the buried material, it is unlikely that these contaminants are associated with the burial cells. No estimate of volumes of contaminated areas is offered.

Associated chemical and physical properties of the source areas consist of various industrial wastes and soil backfill in the burial cells, and sands, silts, and clays of the UCRS in the remainder of the SWMU (BJC 2001c).



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Additional Data Needs

During the WAG 3 investigation, the principle study questions were answered with the data collected; therefore, no additional data are necessary to complete additional FS determinations.

2.1.6 C-747-A Burial Ground (SWMU 7)

Area Description

The C-747-A area is located in the extreme northwest corner of the PGDP secured area. Fig. 2.6 shows the location of SWMU 7. SWMU 7 comprises the eastern two-thirds of C-747-A. The SWMU is bounded on the north and south sides by perimeter ditches, on the west side by the C-747-A Burn Area (SWMU 30), and on the east side by the C-746-E Contaminated Scrap Yard. SWMU 7 covers approximately 22,380 m^2 (240,900 ft^2) and includes five discrete burial pit areas (Burial Pits B, C, D, F, and G) (DOE 1998a). The total area of each pit is listed below:

- Pit B: 948 m^2 (10,200 ft^2)
- Pit C: 892 m^2 (9,600 ft^2)
- Pit D: 195 m^2 (2,100 ft^2)
- Pit F: five areas each $\leq$ 167 m^2 (1,800 ft^2)
- Pit G: 306 m^2 (3,300 ft^2)

Records indicate the burial pits were excavated to a depth of 1.8 to 2.1 m (6 to 7 ft) below the surface, filled with wastes, and covered with approximately 0.9 m (3 ft) of earth; however, the Phase II Site Investigation discovered waste to a depth of 3 m (10 ft) on the west side of Burial Pit B, and borings sampled waste to a minimum depth of 2.4 m (8 ft) in Burial Pit C (Union Carbide 1978). A stockpile of radiologically-contaminated scrap drums, locally known as Drum Mountain, was formerly located over the southeast corner.

The land surface slopes within SWMU 7. Burial Pits B and C form a slight hill on the north side of SWMU 7, and the F Burial Pit forms a lesser mound on the south side of the SWMU. Pit D underlies a level area north of where Drum Mountain once was. Shallow drainage swales occur on the west side of Burial Pit B and between Burial Pits C and D. The ground surface is covered by grassy vegetation except where gravel roads extend through the site.

Henry silt loam is the predominant soil type at SWMU 7. The Henry soil series contains poorly drained, acidic soils that have a fragipan. This type of soil usually is formed in loess or alluvium. This fragipan layer is likely to remain intact, exclusive of the immediate burial pit area. Henry soils typically have moderate permeability above the fragipan and low-permeability within the fragipan. Permeability in the fragipan is less than 1.41×10^{-4} cm/s (0.4 ft/day) (DOE 1998a).

During the Phase II Investigation, double-ring infiltrometer tests were conducted on surface soils at SWMU 7. Average long-term infiltration rates ranged from less than 2×10^{-6} to 2×10^{-3} cm/s (less than 5.7×10^{-3} to 5.7 ft/day) (CH2M Hill, 1992).

The upper 6 m (20 ft) of soils at SWMU 7 consists of surface soil, fill, and loess, alternatively described as silt or clay in the area boreholes. Surface soils, to a depth of 15 cm (6 in), were sampled and described during the Phase II Site Investigation. Soil textures range from sand with gravel to lean clay with gravel. Logs of deeper soil borings demonstrate that coarse textures generally are limited to the upper 0.6 m (2 ft), with the exception of the burial pits that are now known to be as much as 3.0 m (10 ft) deep.

The surface water that drains from SWMU 7 into the surrounding ditches is carried west through Outfall 001 and on into Bayou Creek. In 2002, a sedimentation basin was constructed to contain run-off from PGDP scrap yards. Runoff now flows into the sedimentation basin and is released periodically into Outfall 001.

Process History

The PGDP used the burial pits for disposal of wastes from 1957 to 1979. Burial Pits B, C, and G were used for disposal of noncombustible, contaminated and uncontaminated trash, material and equipment. Contaminated concrete removed from the C-410 Feed Plant during May and June 1960 was placed in Burial Pits D and E. The F Burial Pit was used for disposal of uranium-contaminated scrap metal and equipment. Empty uranium and magnesium powder drums also were reported to have been buried in Burial Pit F (Union Carbide, 1978).

Previous Investigation Conclusions

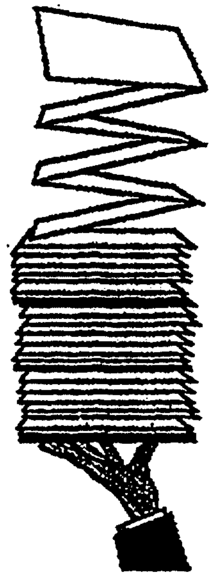
The primary contaminant of surface soils within SWMU 7 is uranium. Total elemental uranium in surface soils ranges as high as 1,400 mg/kg near the northeast corner of the SWMU. In general, uranium activity in surface soils is highest on the eastern edge of SWMU 7 and in a north/ south oriented band in the western half of the SWMU. The level of contamination of surface soils beneath Drum Mountain has not been measured. A radiation walkover survey of SWMU 7, from the Phase II Site Investigation, revealed that radiological surface contamination exceeded the background gamma radiation level of a nearby reference site over approximately two-thirds of the SWMU by a factor of 3 (DOE 1998a).

The metals beryllium, chromium, copper, nickel, and zinc frequently are detected at concentrations slightly above background in surface soils across SWMU 7. PAHs likewise are detected at low concentrations in surface soils. PCB concentrations typically are below 0.1 parts per million (ppm) but increase to as much as 1.8 ppm on the west side of SWMU 7 (sample 55-01). PAHs range between 0 and 24 ppm in the SWMU.

Soil erosion from SWMU 7 appears to be contributing elevated concentrations of copper, nickel, and zinc to the south drainage ditch and uranium and low levels of metals contamination to sediments and surface water in the north drainage ditch. Scrap yards to the east of SWMU 7 are upgradient sources of the same contaminants to the north ditch. Upgradient sources account for a high uranium activity in the south ditch.

Subsurface soils, outside of Burial Pits B and C, do not appear to be contaminated. In Burial Pits B and C, soils contain high activities of uranium and concentrations of cadmium, chromium, copper, nickel, and zinc above background levels. Soil samples from Burial Pits D and F have little to no contamination.

Metals and uranium (at high activities) contaminate water from Burial Pits B, C, and F. The groundwater from Burial Pits B and C also is contaminated with benzene, toluene, ethyl benzene, and xylenes (BTEX) compounds and fuel-related SVOCs (possibly from equipment that was disposed), as well as with vinyl chloride. Water from Burial Pit F contains low levels of VOCs. In contrast, the primary UCRS contaminants are TCE and its degradation products, essentially with no uranium. Groundwater from the RGA is contaminated with TCE, at high concentrations indicative of DNAPL occurrence. High dissolved TCE levels near the base of the RGA are attributable to PGDP's Northwest Plume, which is sourced from DNAPL at the C-400 Building, located upgradient of SWMU 7. The variability of TCE levels in samples from MW 66, located north of SWMU 7, suggests the possibility of a SWMU 7 DNAPL source for contamination in the upper RGA. This variability also may be due to the Northwest Plume.



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An investigation of the "Work for Others" activities at Paducah was initiated in 1999. An extensive search for additional burial sites was conducted. The report concluded that no new additional disposal sites could be identified (DOE 2000d).

Additional Data Needs

Additional geophysical survey data are needed in the area where Drum Mountain was located and also in the Burial Pit E area (outside of SWMU 7). In addition, borings within this area may be needed to characterize the soil at varying depths. A radiological walk-over survey also may be needed to ensure that all hot spots are identified.

2.1.7 C-747-A Burn Area (SWMU 30)

Area Description

SWMU 30 includes the western one-third of C-747-A. Fig. 2.6 shows the location of SWMU 30. It consists of a historical burn-and-burial pit (Burial Pit A) and the location of a former incinerator. The SWMU is bounded on the north and south sides by ditches, on the west side by Patrol Road, and on the east side by C-747-A Burial Ground (SWMU 7). The unit encompasses approximately 11,892 m^2 (128,000 ft^2). The pit is reported to have been excavated to a depth of 3.7 m (12 ft) and covered with 1.2 m (4 ft) of earth. The land surface slopes gently, and a slight mound rises over Burial Pit A. SWMU 30 is bordered by drainage ditches on the north and south side. Grassy vegetation covers the ground except where gravel roads extend through the site.

The soil survey of McCracken County maps Henry soil loam across SWMU 30. However, all deeper soils borings, including Phase II Site Investigation borings H-211 and H-212, MW 66 and boring S-2, encountered surficial fill materials to depths of 0.6 to 3.7 m (2 to 12 ft). Phase II surface soil sample sites H-361 through H-366, H-370 and H-373 provide characterization of surface soil texture from eight locations across SWMU 30. The upper 15 cm (6 in) of soil ranges from lean clay to sand. Surface soil samples from the Burial Pit A area tend to be lean clay with gravel, whereas surface soil textures from the south side of SWMU 7 range from lean clay to silty sand with gravel (DOE 1998a).

The Phase II Site Investigation included double-ring infiltrometer tests on surface soils at three locations. Average long-term infiltration rates were less than 2×10^{-6} cm/s (6×10^{-3} ft/day) for two of the tests.

Process History

SWMU 30 was used from 1951 to 1970 to burn combustible trash, which may have contained uranium contamination. Ash and debris were buried below ground in Burial Pit A beginning in 1962, when use of an on-site incinerator was discontinued. Site maps and a surface electromagnetic geophysical survey of the Phase II Site Investigation identify the location of Burial Pit A. Prior to identification by Phase II Site Investigation surface geophysics testing, it was believed that remnants of the former incinerator were not present. Further research identified images of the incinerator at the location.

Previous Investigation Conclusions

Surface soil contamination by PCBs and PAHs extends from the site of the former incinerator to the south drainage ditch. All PCB detections but one are less than 4 ppm. The highest sample result was at 15 ppm Aroclor-1260 (the carcinogenic PCB). The highest sample result for PAHs concentration is 48 ppm. Uranium activity of the surface soil is generally less in SWMU 30 than was observed at SWMU 7. The radiation walkover survey of SWMU 30, conducted during the Phase II Site Investigation, identified only isolated areas where surface radiological contamination exceeded three times background activity as measured at nearby reference sites (DOE 1998a).

An FS for SWMUs 7 and 30 was completed in November 1998 (DOE 1998a). Although the FS concluded that SWMU 30 is contributing PCBs to sediments and surface water in the south ditch, elevated levels of metals and uranium occurring in both the north and south drainage ditches appear to be derived from upgradient sources.

Subsurface soils are contaminated with metals and radionuclides at the former incinerator site. Soil samples from Burial Pit A contain elevated levels of metals, radionuclides, and PAHs.

Metals, radionuclides, BTEX compounds, and TCE degradation products contaminate water in Burial Pit A. Despite high activities of uranium in some Pit A water samples, elevated uranium activity is not detectable in the adjacent UCRS. TCE contamination of the UCRS and RGA at SWMU 30 may be derived from local sources. However, any DNAPL that may be present has migrated into the underlying soils and is now distinct from the burial pits.

Additional Data Needs

A radiological walk-over survey may be needed at this SWMU to ensure that all hot spots are identified. Where hot spots are identified, surface and/or subsurface sampling may be included during the final scoping for this SWMU.

2.1.8 Area P (SWMU 145)

Area Description

Area P (SWMU 145) is located north of the PGDP security area. Fig. 2.7 shows the location of SWMU 145. The SWMU is approximately 17.81 hectares (44 acres) and began operation in the early 1950s. Currently the C-746-S&T Landfills are located on top of SWMU 145 (DOE 1999a).

Process History

SWMU 145 began operation in the early 1950s. A 1973 document *The Discard of Scrap Materials by Burial at the Paducah Plant* (Union Carbide, 1973), states this area was used by the contractor during the construction of PGDP to discard all types of scrap and waste materials. Use of the area for discarding of scrap and waste by subcontractors was continued until the early 1980s. Construction debris such as concrete, roofing materials, wire, wood, and shingles with asbestos, and welding rods are expected to have been disposed of in the area. Approximately once a year, the accumulated scrap piles were moved by plant personnel into piles or earth depressions and, whenever practicable, covered with dirt. The area was later permitted for the construction and operation of the C-746-S & T Landfills. (BJC 2001).

Previous Investigation Conclusions

In 2000, the Department of Justice completed an investigation of SWMU 145. Five trenches were dug in areas where geophysical surveys identified anomalies. Materials found during trenching activities were roofing materials, construction debris (wood fragments, metal flashing, plastic fragments, etc.), and fly ash (DOE 2001b).

Additional Data Needs

In 2001, a scoping package was prepared that included SWMU 145 related to the entire C-746-S&T Landfill area (BJC 2001). This package summarized data available from the area near this SWMU in both soil and groundwater media. The scoping was used to develop the *Site Investigation Work Plan for the C-746-S&T Landfill at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky* (DOE 2003b). This project was initiated in 2004 in accordance with this plan. The primary focus of the sampling strategy is to collect sufficient groundwater data to determine the following:

Is all of the TCE and ^{99}Tc *detected in the groundwater MWs in the area of the C-746-S&T Landfill originating from upgradient sources?*

Data from this investigation will be available prior to the BGOU RI/FS Work Plan development. Additional soil borings may also be necessary. Placement will be based on results from the C-746-S&T Landfill groundwater investigation mentioned above.

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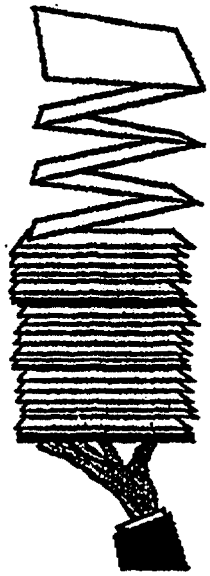

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2.2 PREVIOUS INVESTIGATIONS

Historical data used in this scoping included data from several sources as discussed in section 2.1. Table 2.1 shows a summary of the major investigation data collected.

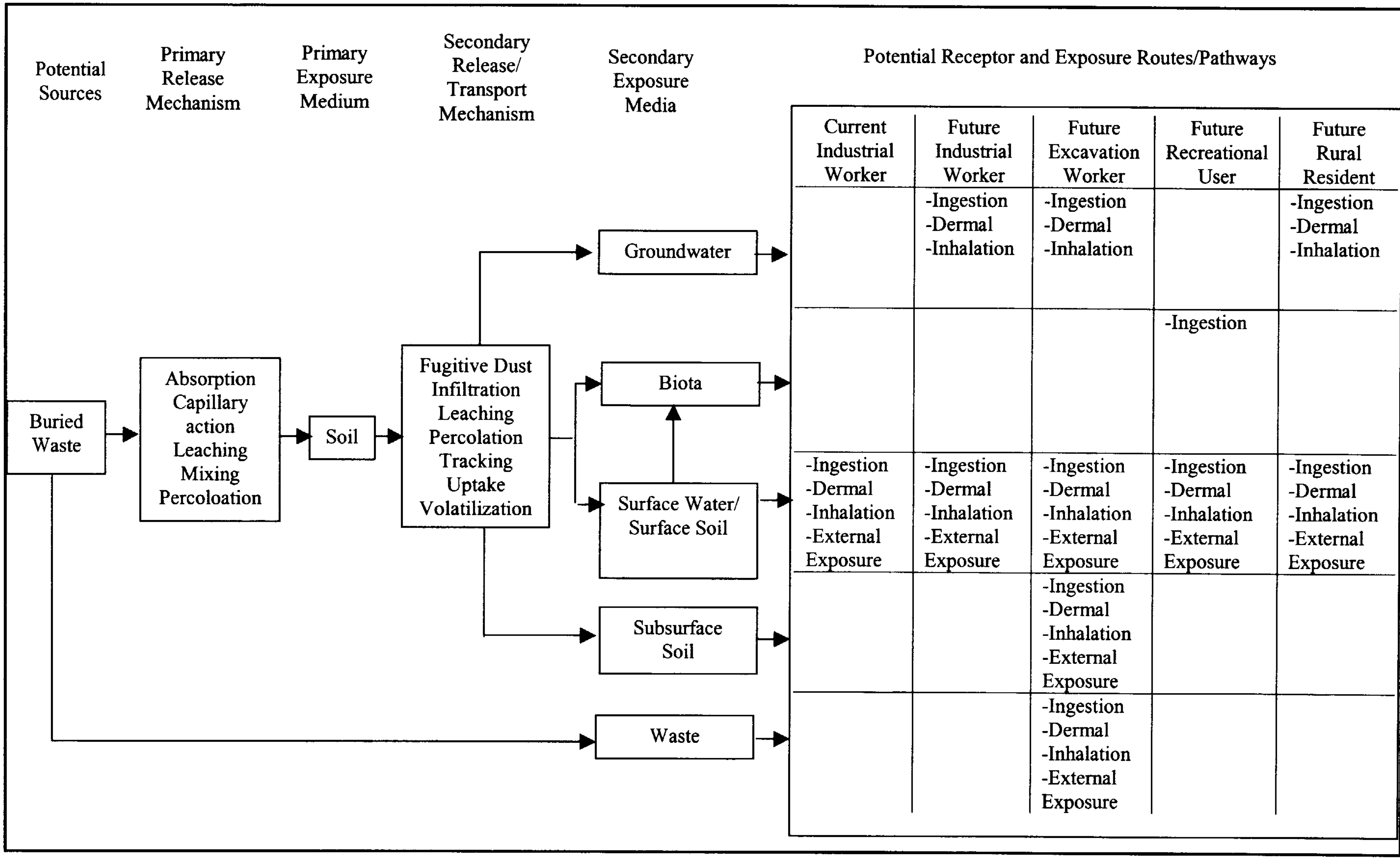
Table 2.1 BGOU previous investigations

Dates	Title	SWMU 2	SWMU 3	SWMU 4	SWMU 5	SWMU 6	SWMU 7	SWMU 30	SWMU 145
1989	Post Closure Permit Application C-404 Low-Level Radioactive Waste Burial Ground		√						
1996	Closure Plan C-404 Low-Level Radioactive Waste Burial Ground		√						
1996-1997	WAG 22 SWMUs 2 and 3 Remedial Investigation and Addendum	√	√						
1996-1998	WAG 22 SWMUs 7 and 30 RI/FS Investigation						√	√	
1998-2001	WAG 3 RI/FS Investigation			√	√	√			
1999-2001	Data Gaps Investigation			√	√		√	√	√
2000-2001	Old North-South Diversion Ditch Sampling								√
2002-2003	Scrap Yards Site Characterization				√	√	√	√	
2003-2004	C-746-S&T Landfill Site Investigation								√

Documents for each of the noted investigations are located in the DOE Document Management Center in Kevil, Kentucky. Information is maintained in the Administrative Record for the BGOU.

2.3 CONCEPTUAL MODEL OF RELEASE

The conceptual site model presented in Fig. 2.8 identifies the probable and potential contaminant migration and exposure pathways at BGOU SWMUs. From the source, two probable pathways are identified: (1) a probable pathway to the adjacent subsurface soils; and (2) a probable pathway to groundwater due to leaching and dissolution of contaminants. These are the primary pathways and will be the focus of the investigation activities. Consistent with the DOE strategy, DNAPL is considered a potential source beneath the buried waste. However DNAPL has not been positively identified beneath any BGOU SWMUs. Potential exposure to contamination at BGOU SWMUs via air is currently limited since the areas are covered with caps and/or vegetative cover.



U.S. DEPARTMENT OF ENERGY
DOE PORTSMOUTH/PADUCAH PROJECT OFFICE
PADUCAH GASEOUS DIFFUSION PLANT

BECHTEL JACOBS COMPANY LLC
MANAGED FOR THE US DEPARTMENT OF ENERGY UNDER
US GOVERNMENT CONTRACT DE-AC-05-03OR22980
Oak Ridge, Tennessee • Paducah, Kentucky • Portsmouth, Ohio

CDM

Fig. 2.8 BGOU SWMUs conceptual model

The primary focus of the sampling strategy will be to collect sufficient data to characterize the nature and extent of contamination and to support a human health and ecological risk assessment and to evaluate remedial alternatives for each SWMU. A set of decision rules has been developed that summarizes the questions to be answered by the RI/FS and identifies the general data needs required to meet the stated goals of the investigation. These general decision rules are the foundation on which the SWMU-specific sampling programs will be developed.

The DQO process was used to focus the sampling strategy on SWMU-specific media, contamination, and migration pathways. The DQO process was also used to identify the data requirements for the baseline risk assessment and FS. The overall sampling strategy for all BGOU SWMUs will focus on surface soils, subsurface soils, sediments (where applicable), and groundwater (UCRS, RGA, and McNairy) to identify sources of groundwater contamination. Sampling at these SWMUs also will investigate known or suspected release mechanisms and will define the migration routes of contaminants and the methods of migration. Of particular interest will be the determination if the SWMUs and potentially related secondary sources are contributing to contamination of the RGA.

2.4 LIKELY RESPONSE SCENARIOS

During scoping, risk analyses will be performed to:

- determine if site risks (or doses) are so great as to require immediate action prior to RI/FS (i.e., early action);
- determine if site risks (or doses) are so low as to support a no-further-action decision;
- prioritize the further investigation of those sites not requiring early action or potentially requiring no further action; and
- provide information to be used in subsequent work plan development.

2.5 NEED FOR DATA COLLECTION

To perform the screening analyses during site scoping, available data must be deemed sufficient to determine the potential contamination at a site. Therefore, data used during site scoping should be from samples collected using approved, documented collection techniques and analyzed using approved, documented analytical techniques.

2.6 TYPE, QUALITY, AND QUANTITY OF DATA

Various sample collection methods will be utilized during this investigation. A combination of field measurements, fixed-base analytical methods, and geophysical survey methods will be utilized to meet the specific DQOs for each SWMU. Sampling and analysis will be in accordance with SW-846 or other approved methodology.

Sediment Sampling

Sediment samples will be collected from the drainage ditches when necessary for BGOU SWMUs. Sediment sampling will be collected with a disposable spoon or trowel in accordance with Paducah procedure PTSA-4205, "Collection of Sediment/Sludge Samples."

Surface Radiological Screening Survey

A radiation screening walkover survey will be conducted for some SWMU surface areas using a sodium iodide detector. Areas that exhibit two times background will be flagged in the field. Gamma spectroscopy will be performed on those soils to determine the presence of uranium isotopes (^{234}U, ^{235}U, and ^{238}U) as well as other isotopes. Gross alpha and gross beta will be determined for each soil sample collected that exhibits greater than $2 \times$ background from the sodium iodide scans; if the gross alpha to gross beta ratio exceeds 3:1, alpha spectroscopy will be performed to identify alpha-emitting isotopes.

Surface Soil Sampling

Surface soil samples will be collected with a 4-in-outside diameter bucket hand auger and/or a 5-cm (2-in)- outside diameter split-core sampler or stainless steel spoon in accordance with Paducah procedure PTSA-4201, "Surface Soil Sampling."

Subsurface Soil Sampling

Subsurface soil samples from soil borings will be collected in accordance with Paducah procedure PTSA-4202, "Subsurface Soil Sampling." The specific sample equipment selected will be appropriate to the drilling technology being used. Soil samples collected using direct-push methods will be collected in accordance with PTSA-4203, "Geoprobe/Terraprobe Surveys" using a sampler fitted with a clear acetate liner.

Soil will be collected from both vertical soil borings and angled soil borings wherever specified. Some vertical soil borings will be advanced with soil samples collected at discrete intervals determined by preset depths. In addition, angled soil borings will be advanced under the burial units at designated SWMUs.

Groundwater Sampling

Groundwater samples may be collected from multiple discrete depths within the RGA using temporary borings at several locations. Water sampling will begin at the top of the RGA (approximately 15 m [50 ft] bgs) and then continue every 3 m (10 ft) until the base of the RGA is reached (approximately 31 m [100 ft] bgs). This strategy results in 2 to 6 water samples from each boring, depending on the thickness of the RGA actually present in the boring. The borings will be drilled using methods that allow collection of discrete-depth water samples with minimum vertical cross-contamination. Three methods used previously at the PGDP that meet this requirement include dual-wall reverse circulation (DWRC), rotary sonic, and a combination of direct push technology (DPT) and hollow stem auger (HSA) drilling. Each of these drilling methods is described in more detail below. The drilling method selected will influence the water sampling method used.

Both DWRC and rotary sonic drilling allow collection of the water sample inside the drill pipe from the sediments at the face of the drill bit. As soon as each water-sample depth is reached and drilling stops, a water-level indicator will be placed in the hole, and the water level will be monitored each minute for up to 15 minutes.

The purpose is to determine how fast the water level returns to equilibrium. The faster the water level stabilizes, the more permeable the interval being sampled and the greater the potential for the interval to be a preferred pathway for contaminant migration. After the groundwater level stabilizes (or after 15 minutes, whichever occurs first), the sampling pump will be lowered into the boring and the sample collection process begun. The first step will be to purge the well. A bladder pump may be used to purge the boring and to collect water samples. Purging is required to eliminate the impact of the drilling fluid (air for DWRC and potable water for rotary sonic) on the interval being sampled. Since sampling will take place immediately after drilling ceases, there will be no stagnant water to remove from the boring and, therefore, no minimum purge volume. The water sample will be collected after sufficient water has been purged to allow geochemical parameters (i.e., pH, dissolved oxygen, conductivity, and temperature) to stabilize within the boring and to return to original aquifer conditions, as measured in existing MWs in the area. The geochemical parameters will be considered stabilized when the following criteria are met:

- at least three measurements, each taken three minutes apart, have consistent readings for temperature, conductivity, and pH;
- temperature measurements agree within 1° C;
- conductivity measurements agree within 10%; and
- pH measurements agree within 0.5 units.

Values from area wells will be referenced to confirm that the stabilized values represent groundwater values and are not the result of groundwater being displaced by a large volume of potable water invading the sample interval during drilling. There is some natural variance across the area, so values from existing wells will be used as indicators of aquifer conditions, but not as specific reference values to determine stabilization within an individual boring. The pH value is the most useful indicator since the pH of RGA groundwater is around 6.5 units, while the pH of the PGDP potable water that may be used during drilling is 7.5 to 8 units.

When the geochemical parameters have stabilized, the flow rate of the sampling pump will be adjusted to 200 ml/minute or less for sampling. Groundwater samples will be collected. During each sampling event, the field parameters of depth to water, groundwater temperature, pH, specific conductance, oxidation reduction potential (Eh), and dissolved oxygen will be collected. After sampling is completed, the sample tubing and pump will be removed from the boring and decontaminated in accordance with approved procedures prior to its next use. Before drilling resumes, the groundwater level will be measured again to determine if any changes occurred during sampling.

The HSA/DPT combination permits the use of DPT-type water sampling probes within the RGA. The drive-point water sampler is pushed or driven below the bottom of the augers, permitting collection of a relatively undisturbed water sample with minimal cross-contamination. When the drive-point sampler has reached the target depth, the mechanism allowing collection of a groundwater sample will be activated. Groundwater will be pumped to the surface, typically with an inertial pump or mechanical bladder pump, although some air- or inert gas-driven systems are available and are preferred. The small inner diameter of the drive-point sampler limits the types of pumps that can be used with this system. A small amount of water, typically less than a gallon, will be purged to reduce the initial turbidity of the water sample. Since sampling will take place immediately after drilling ceases, there will be no stagnant water to remove from the boring and, therefore, no minimum purge volume. The water sample will be collected after sufficient water has been purged to allow geochemical parameters (i.e., pH, dissolved oxygen, conductivity, and temperature) to stabilize within the boring. The geochemical parameters will be considered stabilized when the following criteria are met:

- at least three measurements, each taken three minutes apart, have consistent readings for temperature, conductivity, and pH;

- temperature measurements agree within 1° C;
- conductivity measurements agree within 10%; and
- pH measurements agree within 0.5 units.

After purging, groundwater samples will be collected. During each sampling event, the field parameters of depth to water, groundwater temperature, pH, specific conductance, Eh, and dissolved oxygen will be collected.

Drilling Methods

The following sections briefly describe each of the three drilling methods suggested for use for the BGOU RI.

Dual-Wall Reverse Circulation

DWRC is an air rotary drilling method using two concentric strings of drill pipe. In traditional air rotary drilling, the air travels through the center of the drill pipe, exits the bit, and returns to the surface by way of the annulus between the borehole wall and the drill pipe. The DWRC method is different from air rotary drilling in that the air used to lift the drill cuttings to the surface goes down the annulus between the two strings of drill pipe, exits at or near the drill bit, and returns to the surface through the center of the drill pipe. The drill bit is only slightly larger in diameter than the outer diameter of the outer drill string, resulting in almost no annular space between the drill pipe and the borehole wall. This minimal annular space and the reverse circulation of air prevents contact of the air with the wall of the boring and results in little opportunity for cross-contamination. The upward velocity of the air returning to the surface with the drill cuttings is on the order of 31 m (100 ft) per second, which means that drill cuttings caught at the outlet of the air discharge cyclone are representative of the sediments at the face of the drill bit. To prevent oil contamination of the air stream, a filter normally is placed at the outlet side of the air compressor and is required if this drilling method is selected for the investigation.

When an interval for water sampling is identified, rotary drilling stops, but air circulation is maintained for a brief period to clear the hole of cuttings. After air circulation stops, water from the sample interval enters the drill pipe through the bit, allowing collection of the water sample in the protected environment of the drill pipe. The speed at which water enters the drill pipe and reaches a static water level is an indication of the hydraulic conductivity of the interval being sampled. The faster the water level stabilizes, the greater the hydraulic conductivity. Because some warm air may enter the interval being sampled, purging prior to sampling is recommended. Water temperature and dissolved oxygen, in particular, should be monitored during purging. When these return to *in situ* values, water samples may be collected. Sampling may be done using a bladder pump suitable for a 5-cm (2-in) MW.

Waste generation consists of drill cuttings and water. Drill cutting volumes are near theoretical hole size, since the air circulation does not erode the borehole wall. The volume of water produced is dependent on the productive capacity of the sediments. Aquifers capable of producing large volumes of water can result in significant wastewater volumes.

DWRC drilling has been used for groundwater characterization at PGDP in the Phase IV Investigation; the Northeast Plume Interim Remedial Action; the WAG 6, WAG 27, WAG 28, and WAG 3 Remedial Investigations; and the "Data Gaps" investigation.

Rotary Sonic

Like DWRC, rotary sonic drilling uses two concentric strings of drill pipe with a drill bit designed to create minimal annular space between the drill pipe and borehole wall. Like DWRC, this configuration virtually eliminates vertical cross-contamination. Water sampling, using the same methodology, also takes place within the protected environment of the drill pipe where water from the interval being sampled enters the drill pipe through the drill bit. The primary differences are the method by which the drill string is advanced and the removal of the drill cuttings.

Rotary sonic drilling uses a combination of rotational movement and sonic resonance, which vibrates the drill string down through the sediments. The vibratory motion displaces the sediments laterally. The sediments near the outside of the drill string are pushed to the side of the borehole, while the sediments nearer the center of the drill string are captured as a core in a sleeve in the inner string of drill pipe. This drilling method results in a continuous core of sediments from the surface to the total depth of the hole as a natural by-product of the drilling process, rather than as an extra step requiring special equipment.

Rotary sonic drilling can install larger diameter MWs, such as the 10-cm (4-in) wells recently installed at the C-746-S&T Landfill, without requiring the installation of protective casing from the surface to the top of the RGA. This is because the inner drill pipe can be withdrawn prior to well installation, leaving the outer drill pipe in place as a temporary protective casing. The MW then is built inside the outer drill pipe, as the outer drill pipe is withdrawn from the hole. A smaller hole diameter is required, and less well material is required compared to wells installed using hollow stem augers.

Waste generation consists of the soil core and water. Drill cutting volumes are near theoretical hole size since only the soils in the core sleeve are recovered at the surface. Potable water often is used while drilling above the water table to reduce friction and help displace drill cuttings and may return to the surface as wastewater. The volume of purge water produced is dependent on how much water is used during drilling and how quickly groundwater parameters return to *in situ* conditions after drilling stops.

Rotary sonic drilling has been used during the WAG 6 RI and the Site 3A Seismic Investigation.

Hollow Stem Auger/ Direct Push Combination

The HSA/DPT combination uses traditional hollow stem auger drilling combined with a direct push groundwater sampling assembly. The augers, fitted with a temporary plate at the face of the bit to prevent the entry of cuttings, are used to drill to approximately 1.5 m (5 ft) above the interval to be sampled. A DPT groundwater sampling assembly is lowered inside the augers to the temporary plate. Then the DPT assembly is pushed or hammered through the temporary plate and 1.5 m (5 ft) into the sediments below the auger bit to the sample depth. If the DPT assembly cannot be pushed or hammered through the sediments to a depth of 1.5 m (5 ft) below the auger bit, the sample will be collected at the depth at which the assembly stopped. The actual sample depth will be recorded in the logbook and in sampling documentation, as appropriate.

When the drive point sampler has reached the target depth, the mechanism allowing collection of a groundwater sample will be activated. Groundwater will be pumped to the surface, typically with an inertial pump or mechanical bladder pump, although some air- or inert gas-driven systems are available. A small amount of water, typically less than a gallon, will be purged to reduce the initial turbidity of the water sample. After purging, groundwater samples will be collected. During each sampling event, the field parameters of depth to water, groundwater temperature, pH, specific conductance, Eh, and dissolved oxygen will be collected.

After the groundwater sample is recovered, the DPT assembly is withdrawn; the augers are recovered, fitted with a new temporary plate, run back into the hole, and the hole is drilled to within 1.5 m (5 ft) of the next groundwater sample interval.

Geophysical Methods

Geophysical surveys of some of the areas using several methods may be conducted prior to sampling activities. Because the unit is a collection of pits of various depths that are filled with a heterogeneous collection of wastes and backfill soils, the burial ground represents a difficult target for geophysical characterization. Magnetic properties of the metal drums and buried metal scrap offer the best contrast with the native soils for imaging.

First, an EM-61 magnetometer survey will be conducted at the surface of the designated SWMU area to locate the cells where waste material has been buried and identify any undisturbed cells. If undisturbed cells can be found within the SWMU, these will be candidate areas for the collection of soil and leachate samples. The EM-61 survey will be implemented along continuous lines spaced 1.2 to 1.5 m (4 to 5 ft) apart covering an area that will extend 3 m (10 ft) beyond the SWMU boundary. A data logger or USRAD system will be employed for data acquisition.

If the EM-61 method proves ineffective for delineating areas of disturbed and undisturbed cells, a high frequency Ground Penetrating Radar (GPR) survey will be conducted in the SWMU area. Soils to the west of C-749 at the C-745-B Cylinder Drop Test site have been found to significantly attenuate the resolution of GPR. With GPR, a high frequency antenna maximizes the depth of investigation but reduces the quality of response. From previous use of GPR onsite, a resolution of 1.2 to 1.8 m (4 to 6 ft) bgs is expected, which is adequate to delineate to top of the waste cells. The GPR will be implemented using a towed array system over an area extending 3 m (10 ft) beyond the SWMU boundary.

In addition to the surface geophysical methods, Geophysical Diffraction Tomography (GDT) will be employed to determine the depth of waste burial and whether or not the waste is saturated. GDT images seismic velocities of soils from both surface and downhole locations, generating a 3-D model of seismic anomaly. The complex nature of the burial ground may inhibit the modeling from producing an accurate 3-D image of the base of the entire burial ground; however, imaging of the burial cells adjacent to the geophysical boreholes will provide sufficient resolution to determine the depth of those waste cells.

2.7 APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS

Potential site-specific ARARs, to be identified in the decision documents for this remedial action for the BGOU, were considered in the preparation of this scoping document.

3. APPLICABILITY OF STREAMLINED RESPONSE ACTIONS

3.1 REMOVALS

Removal actions are generally short-term, low-cost actions for situations that require a rapid response. Removal activities are not intended to replace, compromise, or exclude future remedial actions, including early remedial actions. Removal actions are intended to mitigate threats to human health and the environment until a remedial action can be implemented.

3.2 EARLY REMEDIAL ACTIONS

The need for early remedial actions will be evaluated as information is collected during the investigation activities. Remedial actions will be considered as early actions for the BGOU. The following subsections describe the different types of remedial actions and the procedures that will be followed if an early action is deemed necessary. No early remedial actions currently are anticipated for the SWMUs that comprise the BGOU.

3.2.1 Interim Remedial Actions

Early remedial actions would be considered for response to an immediate site threat or for rapidly achieving significant risk reduction; therefore, all early remedial actions will be implemented on an expedited basis. Any early remedial actions implemented at PGDP must be consistent with the requirements of the Comprehensive Environmental Response, Compensation, and Liability Act, the National Contingency Plan (NCP), and the FFA.

The objectives of an interim early remedial action typically are more limited in scope than a final remedial action. If an early interim remedial action is implemented, it will be necessary to finalize interim actions with a subsequent final remedial action. A focused RI/FS, including a baseline risk assessment, will be performed for all early remedial actions and will be consistent with the scope of an interim or final early remedial action.

3.2.2 Final Remedial Actions

Final remedial actions will meet the requirements set forth in the FFA and in appropriate RODs. In accordance with the schedule in Appendix C of the FFA, DOE shall submit a Remedial Action Work Plan with a schedule for implementing the selected remedial action and for submitting a Construction Quality Control Plan, a Post Construction Report, an Operation and Maintenance Plan, and a Final Remediation Report.

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APPENDIX A

BGOU RISK COMPARISON DATA SUMMARY TABLES